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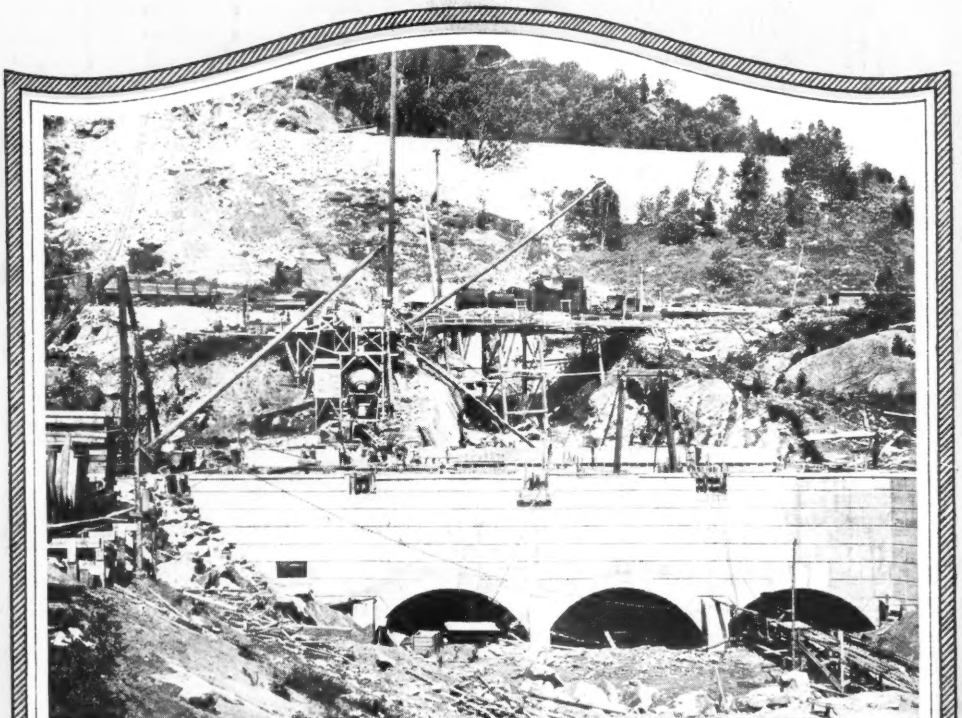


ERECTING THE POWER-HOUSE OF A GREAT HYDRO-ELECTRIC PLANT ON THE DEERFIELD RIVER IN VERMONT

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)

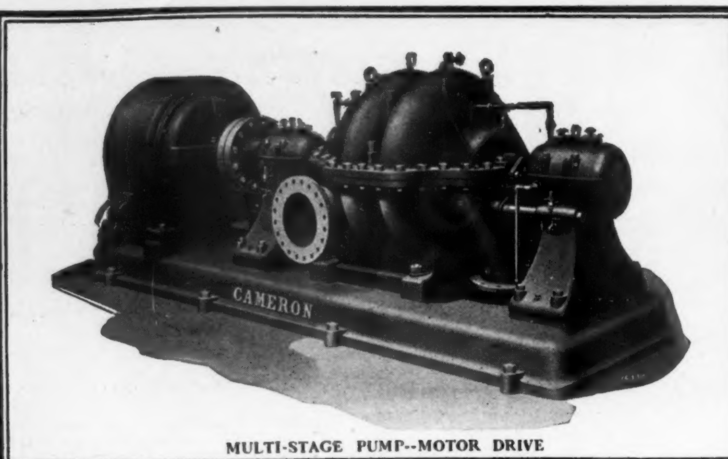
CONTENTS OF THIS ISSUE

Vol. XXVIII, No. X, October, 1923

NOTE—For subscription terms see first Editorial page

Articles

Advertisements



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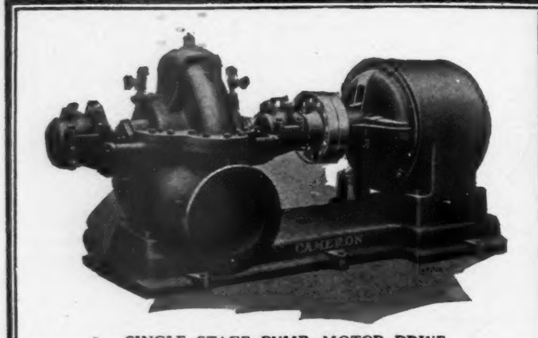
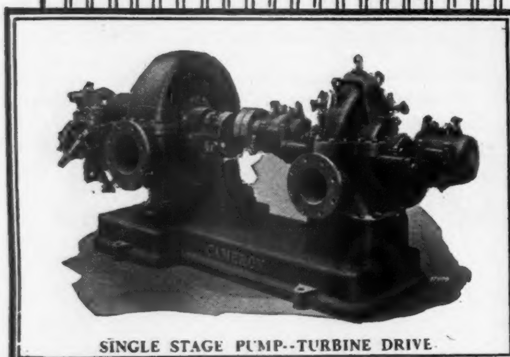


-SINGLE STAGE PUMP--MOTOR DRIVE.



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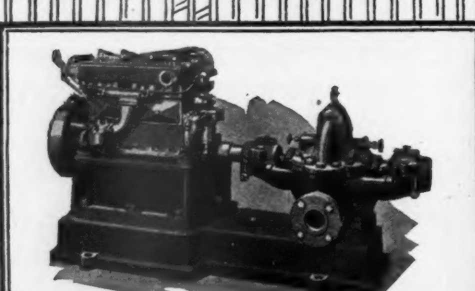

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VOL. XXVIII, NO. X

OCTOBER, 1923

Damming the Deerfield to Produce 60,000 Horse-Power

The Davis Bridge Project of the New England Power Company a Monumental Undertaking Calling for an Expenditure of Eight Million Dollars

By ROBERT G. SKERRETT

NEW England for decades has been conspicuous in the industrial life of the nation because of its varied and extensive manufacturing activities. The demand for power has grown apace, especially in latter years; and more than once the operation of thousands of factories in that section has been menaced by an actual or a potential shortage of fuel.

Unfortunately, all the coal burned in New England has to be brought from other states and from mines more or less remote, and this inevitably adds to the cost of running steam plants. Such being the case, it is easy to understand why a great deal has been done and is being done towards developing the regional water-power resources.

The present story describes a notable effort in this direction which will yield in the near future a block of 60,000 H. P.

THE DEERFIELD RIVER is what is termed a "flashy" stream which drains a section of the Green Mountain region of Vermont, and flows southward to Massachusetts and thence eastward until it meets the much more imposing sweep of the Connecticut. During the past comparatively dry summer months, the Deerfield has given to the casual eye a deceptive impression of its possible maximum energy. In the springtime, however, with the rains falling and the snows melting over a rather expansive watershed, the Deerfield can be a roaring torrent.

Only a few years ago, the New England Power Company turned its attention to the Deerfield not so much because of any great volume of water carried by the stream but rather on account of the fairly pronounced gradient of the valley and the effective heads which could be made available by interposing dams at strategic points. In the interval, this great public utility, which furnishes current to no fewer than 100 communities large and small, has called into being six hydro-electric power plants on the Deerfield and is now engaged in constructing its master work, the so-called Davis Bridge project.

What the New England Power Company is doing on the Deerfield is of the highest suggestive value, for it shows how, under the control of a single management, it is practicable to make the fullest effective use of a stream by so coördinating the resources of a river as to produce a maximum of energy at a minimum of outlay. Not only that, but the resultant balancing of these resources enables the associate hydro-electric plants to distribute their current so as to handle economically the various and the shifting needs of homes and industries over a wide area.

About ten years ago, the New England Power Company created a storage reservoir at Somerset, Vt., for the purpose of controlling in a measure the runoff of the headwaters of the Deerfield during freshet periods so that the floods could be impounded and held in reserve to help steady at other times the volume of water flowing southward to the hydro-electric stations. The primary object of the Davis Bridge project is to form, about 25 miles below the Somerset reservoir, a second basin capable of impounding twice as much water. The two reservoirs will have a combined capacity ample enough to keep the power plants running throughout any dry season.

The main engineering activities involved in the present undertaking are centered in that stretch of the valley lying between Whitingham on the north and a point a short distance south of Readsboro—an area just a few miles north of the Massachusetts-Vermont boundary line. The principal features of the work, by which the natural order of things is to be changed, are: a big diversion tunnel 1,550 feet long; a pressure tunnel 12,800 feet in length; and an immense earth dam, 200 feet high, filling the valley from slope to slope a distance of 1,200 feet. In addition, there is a spillway shaft, driven through the rock, to connect with the diversion tunnel by which excess water will escape from the reservoir and return to the river's course immediately below the dam.

To avoid confusion, let us take up the various aspects of the project one by one, starting with the diversion tunnel which might properly be considered the initial phase of the whole task. As may be readily grasped, provision had to be made for the continuous flow of the Deerfield during the rearing of the dam so that the river could run southward unimpeded to the existing six power stations depending upon the stream for 80 per cent. of their operating energy. Stand-by steam plants furnish the remaining 20 per cent. of the power, and these are called into service to handle peak loads when the Deerfield is low.

The intake end of the diversion tunnel taps the Deerfield at an angle of substantially 90 degrees to its normal flow and at a point on the east bank north of the dam. From there on it swings southward through a wide arc around the dam, with its discharge end coming out below the dam and returning the water by an easy course to the thread of the stream. That portion of the tunnel, at the intake end, which passes through earth is circular in cross section, but thereafter the tunnel pierces solid rock and is horseshoe shaped. In its finished form, whether round or otherwise, the cross-section area of the tunnel is equivalent to that of a circle 23 feet in diameter. During the winter of 1922-1923, when much ice and other floating material were carried down the Deerfield, the diversion tunnel proved fully equal to all demands. As a matter of fact, the tunnel is able to handle a water movement amounting to 20,000 cubic feet per second.

In driving the diversion tunnel, 21 cubic yards of rock were drilled and blasted for each linear foot of advance, and this called for the disposal of 35 cubic yards of muck for each foot of progress. Two modified steam shovels, operated by compressed air, were employed in the tunnel to do the mucking. These shovels were



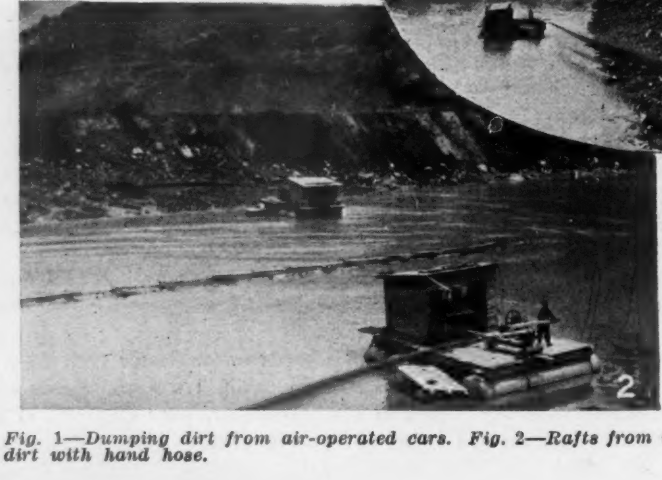
Left—North portal of the pressure tunnel. Center—Switchback for the dirt trains at the north side of the dam. Right—South portal of the pressure tunnel.

equipped with ½-yard buckets; and to fit them for their service each machine was stripped of its boiler and provided with an air receiver. Compressors, located outside the tunnel, furnished the needful air through lines composed first of 5-inch piping and then of sections of 4-inch piping, until within 100 feet of the shovels where hose completed the connections. The tunnel averaged 25 feet in diameter before it was lined with concrete. The lining was done pneumatically, and was shot into place in half-yard charges through 6-inch pipe. Ordinarily, an air pressure of 30 pounds sufficed to blow the concrete, but at times the pressure was run up to 90 pounds to clear the line of "plugs." This tunnel was built by the Rollin Construction Corporation.

Now for the great dam which is rapidly rising above the bottom of the valley and spreading up and down stream for a distance of 1,300 feet. This dam, when completed, will be the highest earth dam yet constructed for hydro-electric purposes. In the language of the engineer, the dam is of the puddled-core type, and is being built by what is termed the semi-hydraulic or modified-hydraulic method—a process which permits of considerably faster work than would be possible if the older form of hydraulic construction were employed.

Anyone familiar with the abundance of rock in Vermont will naturally wonder why a puddled rather than a masonry core was adopted; and the answer is the transformations that took place in the valley thousands of years ago. At some time, when an ice cap covered that part of our continent, a glacier ground its way through the valley filling the underlying bed of the present Deerfield with glacial drift. Because of this deposit, borings made by the engineers failed to reach solid rock after penetrating 150 feet below the bottom of the river. Therefore, in the absence of a rocky ledge on which to rear a masonry core wall, it became necessary to resort to some other type of stabilizing and water-resisting core; and, strange as it may seem to the uninformed, the experts chose an earthen dam with a puddled core—really a center composed of compacted silt washed into place by powerful streams of water.

In order that the reader may get a fairly accurate conception of the formation of this dam, which, in the end, will be fashioned of 1,900,000 cubic yards of earth, let him understand that first a broad trench was dug athwart the valley until a bearing of waterproof clay was uncovered upon which the core of the dam could rest. This trench served as the initial bottom for the "pool," which is shown in some of the pictures accompanying this article. Flanking the trench on its north and south sides, the builders next began to rear walls or causeways of earth, dug from neighboring slopes of the valley, and to extend them from side to side of the valley. As these causeways rose, their inner or adjacent slopes



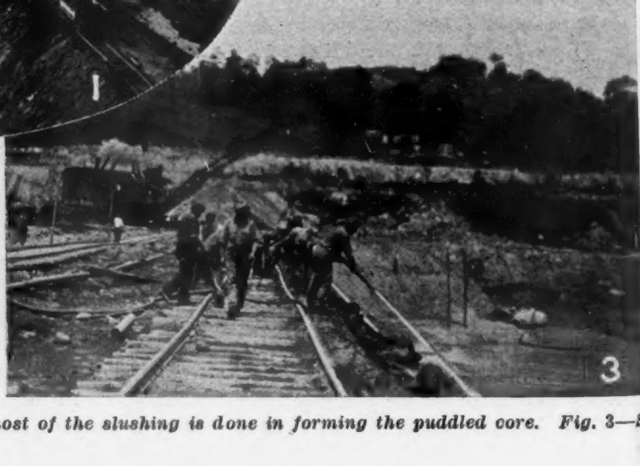


Fig. 1—Dumping dirt from air-operated cars. Fig. 2—Rafts from which most of the slushing is done in forming the puddled core. Fig. 3—Slushing dirt with hand hose.

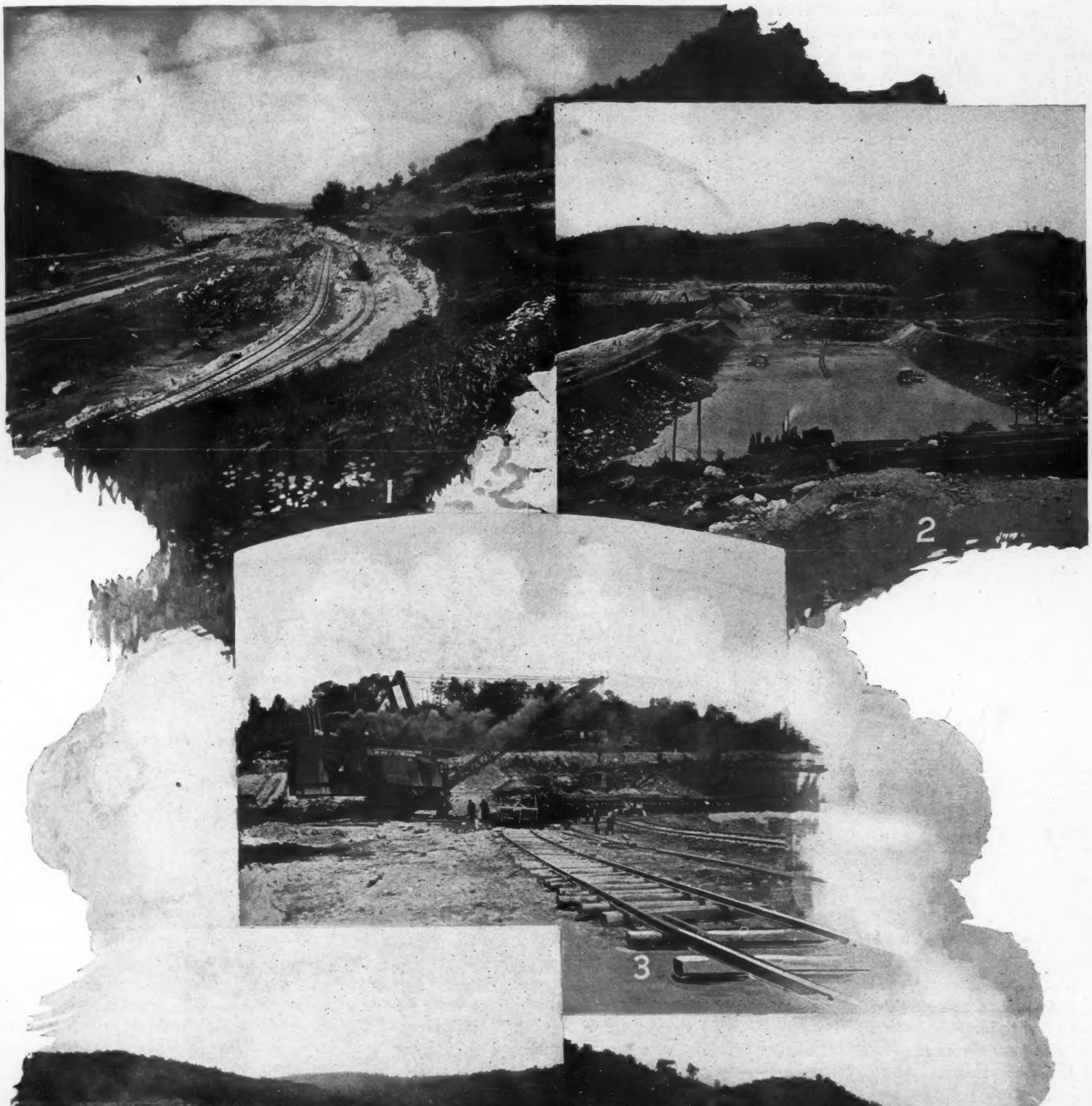


Fig. 1—Looking south down the valley toward the north face of the dam. Dirt train climbing heavy grade at right. Fig. 2—The dam in course of construction viewed from the east slope of the Deerfield valley. Fig. 3—The dragline excavator, with a 100-foot boom, which is capable of handling 3½ yards of material at a time with its mucker. Fig. 4—The dam seen from the west slope of the valley. The pool will form the puddled core of the structure. Fig. 5—Close-up of one of the two rafts equipped with a powerful electrically driven pump which washes down the muck in forming the core of the dam.

were washed with streams of water, and the fine material thus carried down into the pool settled and progressively built up the middle third or core of the dam. It should not be hard to understand that as the core accumulates, its silty substance is compacted under the increasing pressure; and, in time, the center mass will dry out and become as hard as cement and equally impervious to water. The beaches of the pool, at succeeding elevations, have been brought nearer together, and in the end the core will have, in section, the shape of a truncated cone. When completed, the crest of the dam will have a width of 25 feet; and over it the railway, now following the east slope of the valley, will run to reach the west slope where it will travel by a new route to its destination eight miles or more up stream.

Washing down the inner faces of the upper and the lower earth sections of the dam is done for the most part by electrically driven centrifugal pumps carried on two rafts, each of which is supported by three steel tanks or pontoons. These 2-stage pumps are direct connected to 100-H.P. motors; and each pump is capable of throwing 750 gallons of water a minute against a 300-foot head. This work is really an adaptation of hydraulic mining methods. Hand hose, fed by other pumps, are used on the crests of the dikes to supplement the service of the pumps.

The building of this dam is a sort of robbing-Peter-to-pay-Paul process, for the dirt must be dug from various parts of the prospective reservoir by batteries of steam shovels and transported thence to the dam site by trains of dump cars, many of which discharge their burdens by pneumatically operated tilting mechanisms. There are sixteen locomotives on the job shifting this dirt, and they travel over trestles and up 4 per cent. grades and switchbacks in order to reach the continually rising tops of the dam sections. Watching activities at and near the dam for a day gives one a better conception of the enormity of the task and what must be done before the last carload of dirt has been dug, moved, and properly placed. The whole operation looks from afar like the work of an army of ants nibbling away at the limitless body of Nature in an effort to change the valley so as to form a reservoir covering an expanse of 2,000 acres. This basin will have a maximum depth of 196 feet and be capable of impounding 130,000 acre-feet of water. The entire watershed tributary to the Somerset and the Davis Bridge reservoir has an area of substantially 184 square miles. The dam will be finished in time to arrest the abundance of next spring's freshets; and if water enough be allowed to pass onward to keep the plants running farther down the river something like three months will be required to fill the basin. The dam is being built by W. F. Carey Company, Inc.

Before leaving those of the activities which are of a superficial nature, mention should be made of the work involved in constructing the roadways for the several lines over which the dirt trains move and also in clearing a new route on the west side of the valley for the Hoosac Tunnel & Wilmington Railroad. This latter task calls for the raising of the tracks 170 feet above their former level in order to place them where they will be beyond the reach of the water when the reservoir is filled. About eight miles of track will have to be rebuilt. These several incidental jobs have necessitated and still require a great deal of digging and filling in addition to drilling and blasting much rock. In disposing of this rock, no fewer than five Ingersoll-Rand portable compressors are in service today. These machines are of Types Fourteen and Twenty—the smallest being a 6x6-inch unit and the largest a 9x8-inch unit. In relocating the regular railroad, the portables furnish compressed air for the operation of eighteen "Jackhamers" and a No. 33 "Leyner" sharpener.

When the dam is completed and the diversion tunnel is no longer needed to by-pass the Deerfield, the tunnel will be plugged at a suitable point inside of its intake end, and its remaining portion will become an integral part of the spillway system—water reaching the tunnel by a vertical shaft 163 feet deep and 22½ feet in diameter. This spillway shaft, popularly termed the "glory hole" by the men on the job, is surmounted by a great circular intake, having a radius of 80 feet, that is to be finished with a series of converging, curving vanes which will guide the descending water, with an easy vortexlike movement, into the spillway shaft. The spillway system in its entirety will call for the excavating of more than 60,000 cubic yards of rock. This, of course, includes the abandoned portion of the diversion tunnel. The concrete crest of the spillway will lie 14 feet below the crest of the earth dam. It is computed that the spillway will be able to handle 30,000 second-feet of water—a volume 100 per cent. greater than that shown by any flood record of the river. Compressed air for the prosecution of the spillway work is obtained from a power plant located on the east bank of the river south of the dam, where are installed three compressors—one a 14x12-inch Type ER machine of 464 cubic feet capacity and two XB-2 units, each of 888 cubic feet capacity. This plant also supplies air for the drills and other pneumatic equipment at work in the neighboring section of the pressure tunnel. The Rollin Construction Corporation has the contract for the spillway system.

So far, we have considered only those features of this vast undertaking by which the normal course of the Deerfield will be arrested and controlled and by which a large lake will be formed in a part of the valley that hitherto has been of relatively modest economic value. Now let us see how the head of water that will be made available by the dam will be put to service in developing many thousands of electrical horse-power. This brings us to that phase of the project which has to do with the driving of the pressure tunnel through the rocky backbone of a portion of the Hoosac Range for a distance of nearly 2½ miles. This tunnel, when lined with six inches of concrete, will have a cross-section area equivalent to a tube fourteen feet in diameter, and will constitute the conduit by which water from the reservoir will be delivered to the wheels of the turbo-generators which are to be placed in the power house being reared on the east bank of the river, south of Readsboro. The mean operating head will be a matter of 345 feet. The excavational work on the tunnel is now 75 per cent. completed.

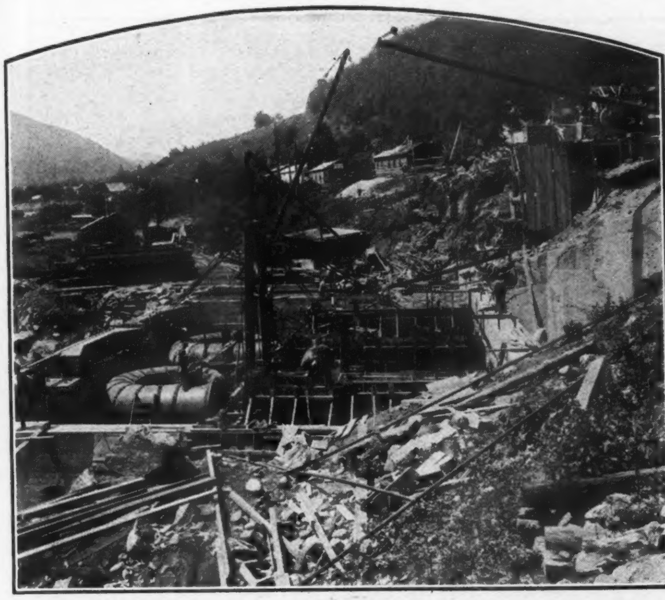
For the sake of exactness, it should be said that the pressure tunnel is to be horseshoe shaped in cross section except for the last 330 feet of its down-stream end, which will be circular and lined with steel 17/32 inch thick. This tunnel lining will terminate in a manifold which will connect with three steel penstocks, each nine feet in diameter. Each penstock, in its turn, will lead to one of the three turbo-generators to be located eventually in the power house. At the start, only two of these 20,000 H.P. machines will be installed. In providing for the installation of the penstocks it will be necessary to excavate 6,000 cubic yards of rock.

The pressure tunnel is being constructed by Mason & Hanger; and from end to end is piercing a solid ledge of mica schist with occasional interposed veins of quartz. For the most part, the rock is not hard but it is tough, and this condition adds somewhat to the task of the drillers. The tunnel is being driven without shafts and from four headings—two of these have taken their points of departure, respectively north and south, from an adit which enters the mountainside, on grade, mid-length of the tunnel. The adit is 800 feet long. The two remaining headings have been driven from points on the east slope of the valley—the north portal entering the mountain on the up-stream side of the dam, while the south portal is located well up the slope and immediately above the power house site.

For the first 1,000 feet at the intake end, the pressure tunnel has been driven on a descending grade in order to get proper cover. From there on the line of the tunnel slopes downward on a gentle gradient of .8 of a foot per 1,000 feet. The writer did not visit the adit and the associate headings, but he was told that the drill-round practice there was substantially identical with that adopted at the headings driven from the north and the south portals—that is to say, an average of 45 holes in the combined heading and bench. To be specific, the heading round consists of from 32 to 33 holes, while from 12 to 14 holes, in two rounds of 7 each, are drilled in the bench. The heading holes are drilled from 8 to 10 feet in depth, and are collared 2¼ inches in diameter, whereas the bench holes are uniformly 6 feet deep.

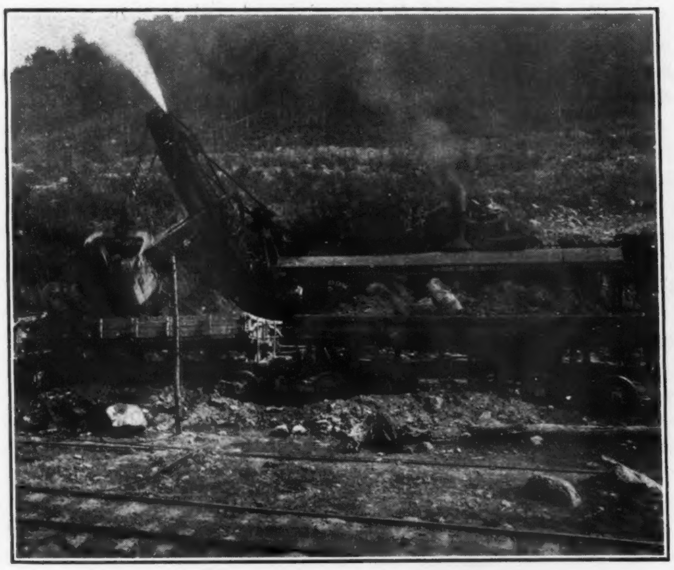
At each heading, there are four No. 248 "Leyner" drills mounted on two columns, and the bench is drilled by a No. 13 DCR "Jackhamer." "Jackhamers" are also employed to drill pop holes in pieces of rock that otherwise are too large to be picked up by the mucking machines or to be loaded into the mucking trains by hand. The latter trains consist of three cars, each having a capacity of from 48 to 50 cubic feet, which are drawn by storage battery locomotives. Two rounds are fired in the course of 24 hours; and the tunneling is carried on in 10-hour shifts.

Comparatively little water finds its way into the tunnel sections, and this seepage is easily taken care of by a few air-operated pumps. Some of these pumps also furnish water to the "Leyner" drills. As might be expected, the tough rock necessitates the fairly frequent sharpening of numerous drill steels, and to facilitate this work the various blacksmith shops on the job are outfitted with "Leyner" sharpeners, Type No. 25 oil furnaces, and "Little



Looking north on the east slope of the Deerfield valley showing parts of two hydro-electric units in the power house under construction.

Drilling rock with a "Jackhamer" just above the north portal of the pressure tunnel of the Davis Bridge project.



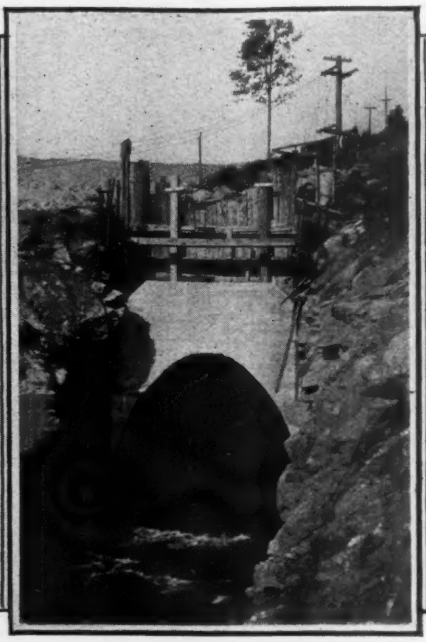
The largest steam shovel on the job digging dirt for the construction of the dam. It is capable of handling 5½ cubic yards at a load.

Heading in the north portal section of the pressure tunnel with four "Leyner" drills at work.

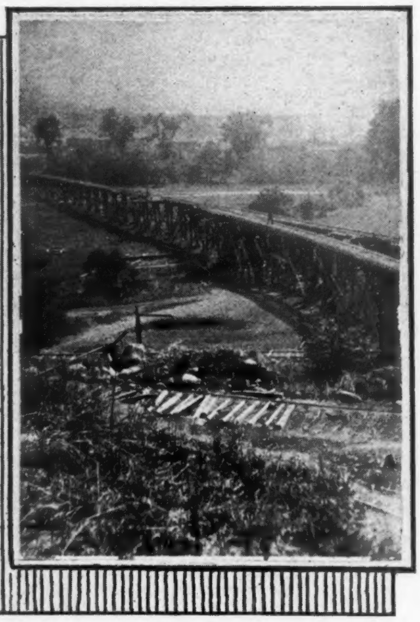
A blacksmith shop at the south portal of the pressure tunnel that is equipped with a No. 50 "Leyner" sharpener and a No. 25 "Leyner" oil furnace.

Portable compressor furnishing air for pneumatic tools used in relocating the railroad which will follow a route about 200 feet above its original position.

North end of the big diversion tunnel.



Discharge end of the diversion tunnel.



Trestle over which dirt reaches the dam.

David" pedestal grinders. As a matter of fact, "Leyner" sharpeners of different sizes are provided for the handling of drill steels wherever rock has to be drilled and blasted on the entire undertaking. It goes without saying that there are a number of compressor plants for furnishing the operating air used extensively not only for the running of drills, sharpeners, pumps, hoisting engines, and riveters, but also for the working of the four Hoar mucking machines employed in the pressure tunnel. Where the activities cannot be reached by the lines from these plants, the needful air is provided by portable compressors.

Just outside the southern portal of the pressure tunnel there is to be erected a gigantic surge-tank of the Johnson differential type. This surge-tank will have a diameter of 34 feet and a height of 183 feet, and, as its name implies, will act as a safety or a relief valve for the absorption of any hammer-blow movement which may originate in the system anywhere between the intake of the tunnel and the Allis-Chalmers water wheels in the power house. This monumental structure of steel is to be furnished and erected by the Riter-Conley Company of Pittsburgh, Pa. The Lancaster Iron Works, of Lancaster, Pa., have the contract for the penstocks; the General Electric Company is providing the big generators; and L. H. Shattuck, Inc., of Manchester, N. H., is building the power house. The power house substructure, which is of concrete, rests entirely on a solid ledge, and has called for the excavating of 4,000 cubic yards of rock. This structure is externally 60 feet wide and 114 feet long; and, as is the practice with the New England Power Company, the superstructure will be of brick with a concrete-slab roof.

Immediately up stream of the power house there will be located an outdoor switching station which will constitute the power-house end of a 75-mile transmission line leading to the main switching station at Millbury, Mass. Energy will be sent over that line at 110,000 volts. On the down-stream side there is to be another outdoor switching station which is to connect with existing lines linked with the plants already in service below on the Deerfield. This station will handle current of 66,000 volts. The building and the erecting of the transmission system will be taken care of by the Power Construction Company of Worcester, Mass., a subsidiary of the New England Power Company. When completed the Davis Bridge project will represent an outlay of fully $8,000,000.

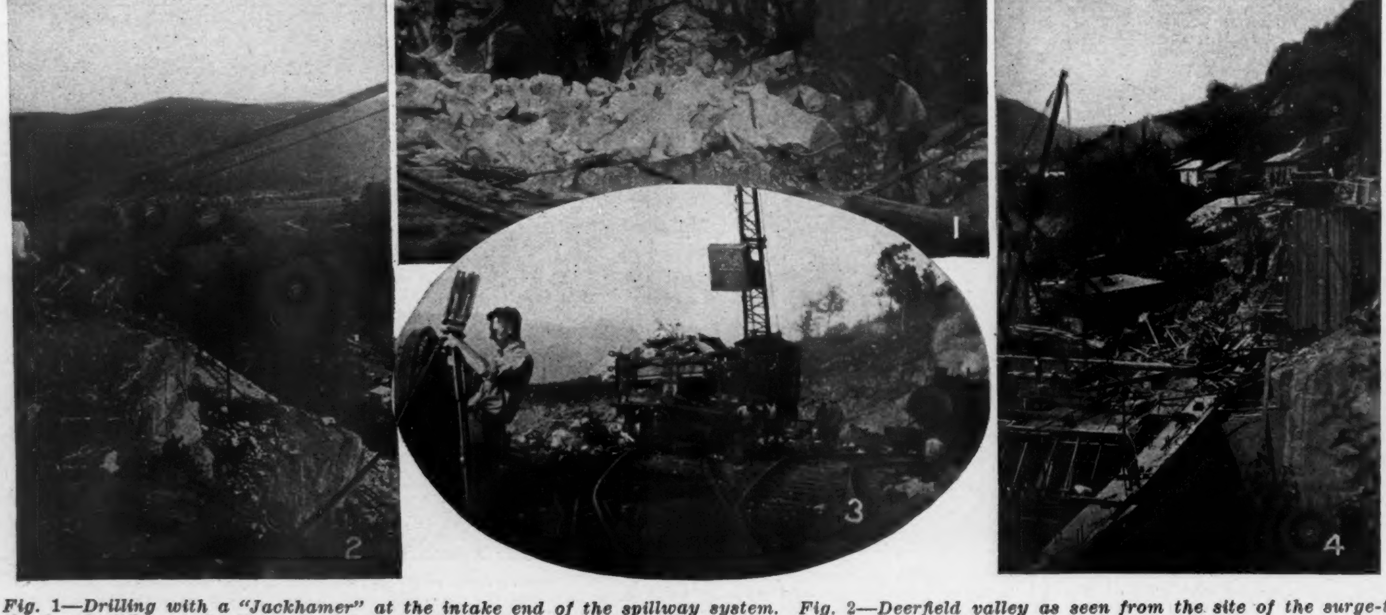
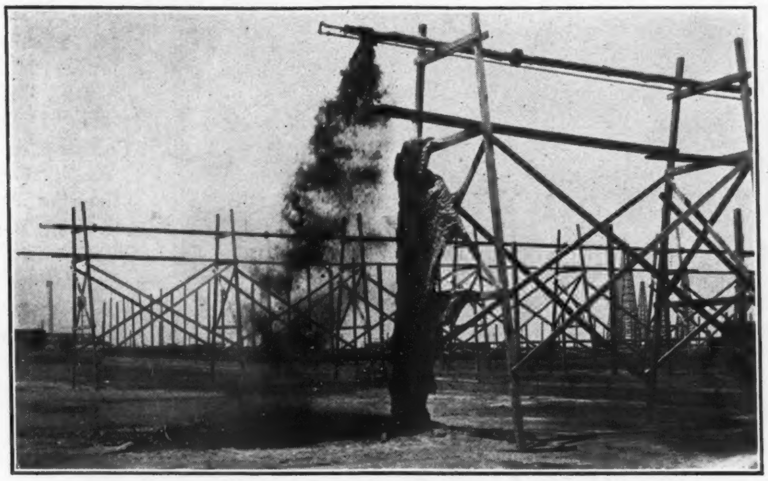


Fig. 1—Drilling with a "Jackhamer" at the intake end of the spillway system. Fig. 2—Deerfield valley as seen from the site of the surge-tank. Fig. 3—On the edge of the "glory hole" or spillway. Fig. 4—Concrete foundation of power house after removal of forms.

Compressed Air In Sulphur Mining

By CLOYD M. CHAPMAN*

COMPRESSED air plays an important part in the operation of the new plant of the Freeport Sulphur Company at Hoskins Mound, Tex. It pumps a substantial portion of the enormous quantities of water that are required in the mining of sulphur by the Frasch or hot-water process; it raises the molten sulphur from the underground deposits to the surface; and it performs many other but less important functions.



Discharge lines from which the molten sulphur is delivered to the great sulphur vats.

To appreciate the work of compressed air in this plant it is first of all necessary to understand the elements of the Frasch process for mining sulphur. The method consists essentially of melting the sulphur in the ground by means of hot water, and of pumping the molten sulphur to the surface. To melt the sulphur, water, at a temperature of approximately 330°F., is pumped down into the sulphur-bearing strata lying 1,000 feet or more below ground. As the temperature of the water is practically that of steam at 100 pounds pressure, the water has to be heated and kept continuously under that pressure lest some of it be converted into steam. The water is therefore pumped under the aforementioned pressure into specially designed heaters, where it comes in direct contact with live steam at the same pressure.

After heating, the water is fed to pumps which increase its pressure from 100 pounds per square inch to such a pressure as may be required to force it into the sulphur well—usually from 150 to 200 pounds per square inch. These booster pumps discharge the high-pressure hot water into covered pipe lines which are run from the heating plant to the various sulphur wells scattered over the producing area. One water heating plant may serve as many as half a dozen wells.

The piping leading down into each well is made up of several pipes, ranging from one inch to ten inches in diameter, placed one within the other. The outermost pipes carry water down to the sulphur-bearing strata, where it passes out of the piping through perforations. Within the water pipes, which are six and eight inches in diameter, is a 3-inch line extending to the bottom of the well. The sulphur, as it melts, flows to the bottom of the well and is raised through this line to the surface of the ground by means of compressed air fed through a 1-inch pipe within the 3-inch line.

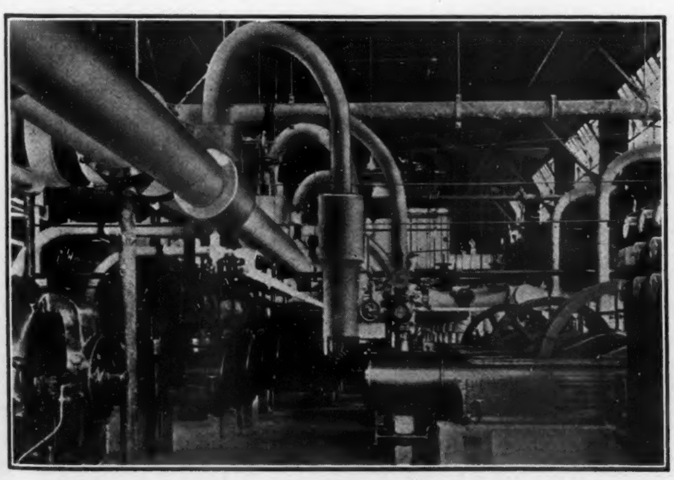
The wells are over 1,000 feet deep; and melted sulphur has a specific gravity of 1.81. Therefore, high pressures and relatively large volumes of air are needful to raise the sulphur to the surface. To start an air lift on a column of water 1,000 feet deep would require 433 pounds pressure; but in the case of liquid sulphur, at the same depth, the necessary pressure would go up to about 780 pounds. In practice, however, the starting pressure is a variable quantity that cannot be predicted accurately owing to differing underground conditions. Operating pressures also vary with different wells and at different times in the same well.

Not only does compressed air raise the sulphur to the surface, but, instead of discharging the liquid at the top of the well into an open tank, it blows the sulphur through a long line of steam-jacketed piping to a receiving station where it is discharged into a concrete tank lined with steam coils. Up to this point, air is the sole medium for handling the liquid sulphur; but from then on it is forced by steam-jacketed, vertical, multi-stage centrifugal pumps through steam-heated lines to the storage pile. Without the air lift, it would be rather difficult to reduce to practice the hot-water system of mining sulphur.

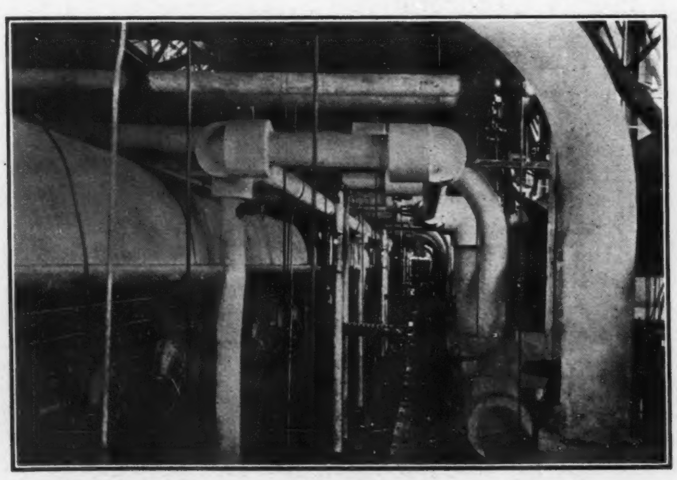
Well water for use in the boilers is pumped by a simple air lift. The water is discharged into a ditch, and flows by gravity to a point near the plant where it is picked up by centrifugal pumps and discharged, after chemical treatment, into the storage reservoir.

We have now outlined the principal uses of compressed air that call for the largest volumes of this operative medium at the highest pressures. There are, however, many minor services to which compressed air is put to considerable advantage. For instance, ejectors, operated by compressed air, prime the centrifugal pumps employed for passing mine and boiler water through the chemical treating process to the storage reservoirs. As compared with a vacuum pump or other priming units,

*Consulting Engineer, New York City.



Interior of the power plant. The high-pressure and the low-pressure compressors which furnish operative air for the mining of sulphur and for other essential purposes at Hoskins Mound.



A battery of boilers and the main steam header. Steam, and much of it, plays a prime part in the mining of sulphur as practiced in the Freeport district.

Power plant and associate buildings of the Freeport Sulphur Company at Hoskins Mound, Tex.

the air ejector for this work is reliable, and inexpensive.

Air-driven turbine tube-cleaners remove scale from pipes and boiler tubes, and pneumatic augers bore holes in the solid, stored blocks of sulphur preparatory to blasting the material down for shipment. Pneumatic hammers, chisels, and drills are utilized for repair and maintenance about the plant; jets of air clean dust from the electrical equipment; and the air brush paints the otherwise inaccessible portions of the buildings and the equipment. Low-pressure air is supplied to the chemical laboratory, where it does many useful services.

One other duty which air is found to perform very satisfactorily at the Hoskins Mound plant is that of handling oil received in tank cars. A storage tank for lubricating oils is located at such a height that oil may flow from it by gravity to measuring pumps for distribution by the storekeeper. This receiver is too high to permit a railway tank car to discharge into it by gravity; but a few pounds of air, applied at the top of the car, easily and promptly forces the oil into the storage tank. No pumps are called for: all that is necessary is an air line leading from the compressor and a pipe connection from the car to the storage tank.

The compressor equipment at this plant consists of two 2-stage, simple, steam-driven machines, each with a capacity of 1,000 cubic feet of free air per minute operating at a pressure of 100 pounds, which supply air for pumping water and for general service, and of five high-pressure, steam-driven compressors for pumping sulphur. Three of the latter are 2-stage, 500-pound compressors, with an individual capacity of 414 cubic feet of free air per minute, and the remaining two are 3-stage, 1,000-pound machines with capacities of 400 cubic feet of free air per minute.

The Hoskins Mound plant is the fifth of its kind to be built for the Freeport Sulphur Company by Dwight P. Robinson & Company, Inc., within the past ten years.

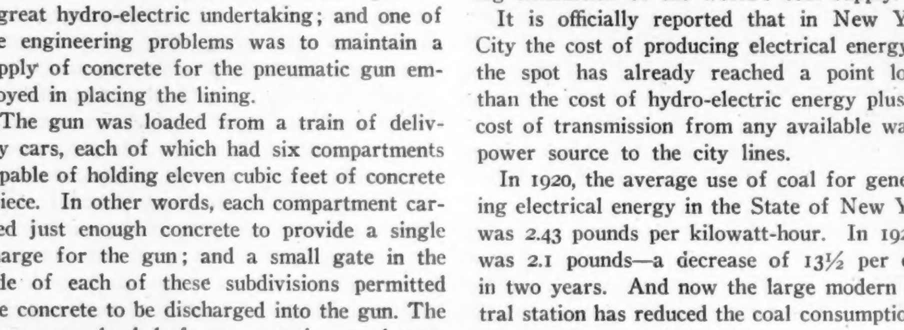
The annual soap bill of the United States amounts to $250,000,000; and every family within its confines—averaging 4.4 persons—used 80 pounds in the fiscal year ending June 30, 1923. And this despite the so-called "great unwashed."

PNEUMATIC HOIST OPERATES MOVABLE HOPPER

SOME MONTHS ago our attention was attracted to a short article in *Engineering News Record*, which described how a movable hopper helped to save time in loading concrete cars used in connection with the lining of the Kern Canyon Tunnel of the San Joaquin Light & Power Corporation of California.

Believing that this topic would be of interest to readers of the Magazine, we have gone to some trouble to obtain additional data, and are now able to supplement the information published by our contemporary. As will be recalled, the Kern Canyon Tunnel forms part of a great hydro-electric undertaking; and one of the engineering problems was to maintain a supply of concrete for the pneumatic gun employed in placing the lining.

The gun was loaded from a train of delivery cars, each of which had six compartments capable of holding eleven cubic feet of concrete apiece. In other words, each compartment carried just enough concrete to provide a single charge for the gun; and a small gate in the side of each of these subdivisions permitted the concrete to be discharged into the gun. The cars were loaded from a stationary hopper which was substantially like the delivery cars except that the outlet gate was made in one long piece so hinged that it could be operated by a lever at either end.



General arrangement of chute, hopper, and delivery car.

Some difficulty was experienced and a good deal of time was lost in spotting the compartments of a car so as to bring its several subdivisions directly beneath the corresponding openings in the hopper. This trouble was effectually overcome by a movable hopper designed by Messrs. Thebo, Starr & Anderton of San Francisco. The modification proved the means of materially speeding up the work. The accompanying diagram makes this clear.

The motive power for the hopper was a "Little Tugger" hoist mounted on one end of the hopper body. Several turns of cable were taken around the drum of the hoist; and each end of the cable was fastened to a stanchion placed at its end of the hopper scaffold or elevated track. When the hoist was operated, being unable to wind up the doubly anchored cable, it shifted itself, and, in traveling horizontally, moved the hopper a matter of fourteen or fifteen feet. Inasmuch as the hoist was reversible, a single machine served to draw the hopper in either direction and thus to spot it to a nicety.

The advantage of that arrangement should be obvious. It made it practicable to move the hopper along beneath the discharge end of the concrete chute, and facilitated the uniform loading of all the compartments. When a delivery car arrived on the track below the hopper, the latter was quickly and accurately spotted by the man in charge, who then tripped the single hopper gate and simultaneously filled the corresponding compartments of the concrete car.

STEAM POWER AT TIMES THE CHEAPER POWER

WATER power is never developed and employed for nothing; and often it may cost more than steam power. This fact, however, does not permit us to ignore the impending exhaustion of the world's coal supply.

It is officially reported that in New York City the cost of producing electrical energy on the spot has already reached a point lower than the cost of hydro-electric energy plus the cost of transmission from any available water-power source to the city lines.

In 1920, the average use of coal for generating electrical energy in the State of New York was 2.43 pounds per kilowatt-hour. In 1922 it was 2.1 pounds—a decrease of 13½ per cent. in two years. And now the large modern central station has reduced the coal consumption to 1½ pounds per kilowatt-hour.

It is far better to be deceived occasionally by a fellow-man than to be distrustful of all men.

A review of the production of gold, silver, copper, lead, and zinc in the State of New Mexico for the past twenty years shows a wide annual fluctuation in the case of each metal; but the gross value of all five minerals in 1922 was more than three times their gross value in 1903.

Our Leviathan of the Air: the ZR-1

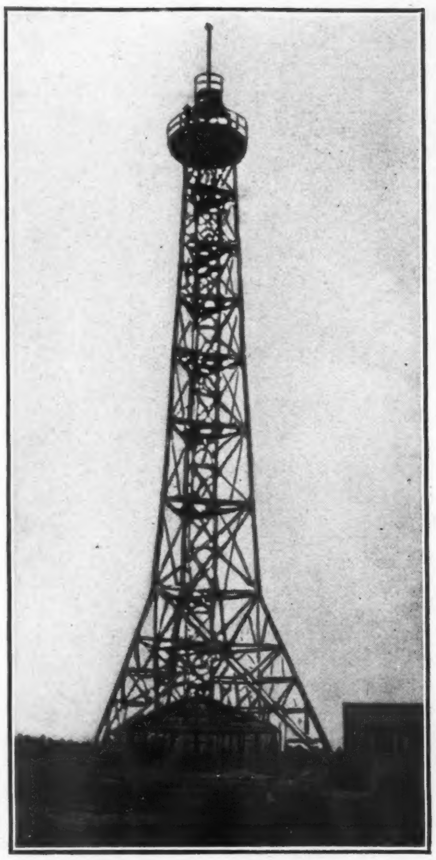
By SIDNEY MORNINGTON

ONCE MORE the United States Navy is doing splendid pioneer work in the field of engineering and venturing undismayed into a realm of exploration which may prove of incalculable value in advancing the commercial use of airships.

In the designing and the building of the great rigid dirigible ZR-1 many technical problems had to be met and solved, and scores of other puzzling questions are to be settled during her initial flights and later on when her maximum powers of endurance are drawn upon for a possible journey across the frigid expanse of the Arctic regions.

Because the ZR-2 collapsed in midair and burst into flame while manoeuvering aloft on her trial trip abroad, and because other dirigibles of a kindred nature have been wrecked or destroyed in one way or another, there has been a tendency in numerous directions to condemn the type offhand and to declare them too weak and too bulky ever to be of any practical service—especially in times of peace. Rear-Admiral W. A. Moffett, Chief of the Bureau of Aeronautics, has consistently maintained an opposite view, and has repeatedly pointed to the really excellent performances of the German Zeppelins under widely varying conditions.

It is not a matter of common knowledge that the Zeppelin L-59, in 1917, voyaged from Bulgaria across the Mediterranean and Egypt and as far over Africa as Lake Victoria Nyanza, where she was recalled by wireless and returned, without a halt, to her starting point at Jamboli. In that flight the L-59 covered a total distance of 4,500 miles, and landed again upon Bulgarian soil with sufficient fuel still in her tanks to have carried her 3,000 miles further. In planning the ZR-1, the aeronautical experts of the United States Navy have profited as far as possible by the experience of the Germans who have, undoubtedly, heretofore lead in the construction of rigid dirigibles of great size. It is only fair to mention that the advice of engineers outside the navy has been freely sought in order that the ZR-1 might represent the present climax of knowledge in this particular field.

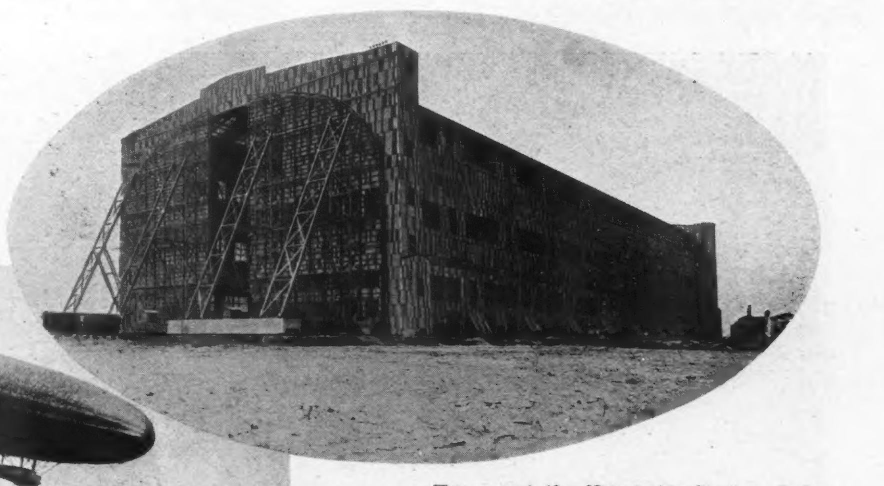


The mooring mast by which the ZR-1 will be held when standing by and ready for a flight from the U. S. Naval Air Station, Lakehurst, N J. The great ship will be able when so secured to ride out a gale in perfect safety.

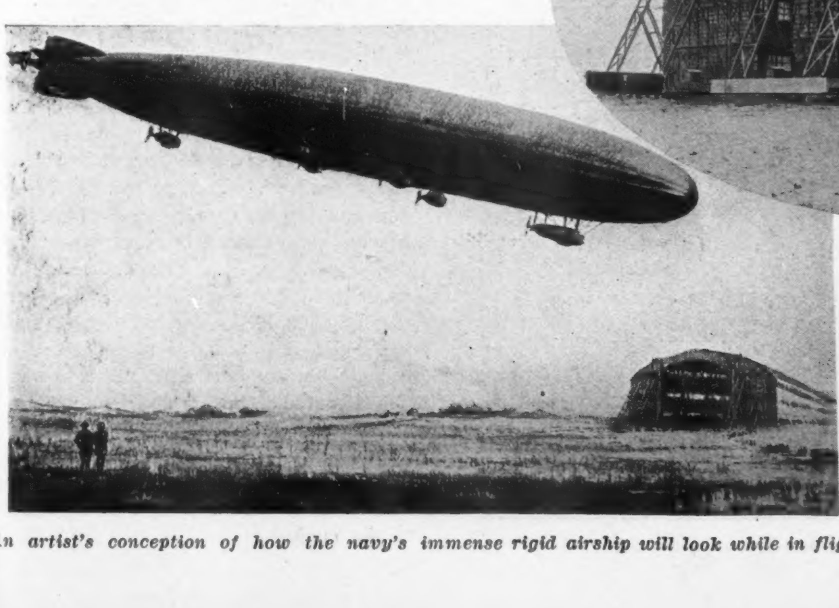
That the layman may grasp something of the skill displayed in the building of the ZR-1, it might be well to mention some of her outstanding features and her principal dimensions. From end to end, the airship is 680 feet long, has a maximum diameter of 79 feet, and will be driven by six gasoline engines capable of developing a total of 1,800 H. P. At full speed, the ZR-1 will make 75 miles an hour, but her cruising speed will be nearly ten miles slower, and at the latter rate she will be able to cover 4,000 miles on her fuel supply. With her twenty gas cells filled with 2,115,000 cubic feet of non-inflammable helium, the ship can rise with a gross dead weight of 120,600 pounds.

As in other aircraft of a kindred type, it has been necessary to combine needful strength with necessary structural lightness, and this would not be feasible but for that metallurgical marvel, duralumin—an alloy of aluminum and copper that is unique in a number of its characteristics. In passing, it should be pointed out that while the structural get-up has been influenced by the best practice abroad still our own engineers have not hesitated to add elements to the framework wherever increased rigidity or strength seemed desirable.

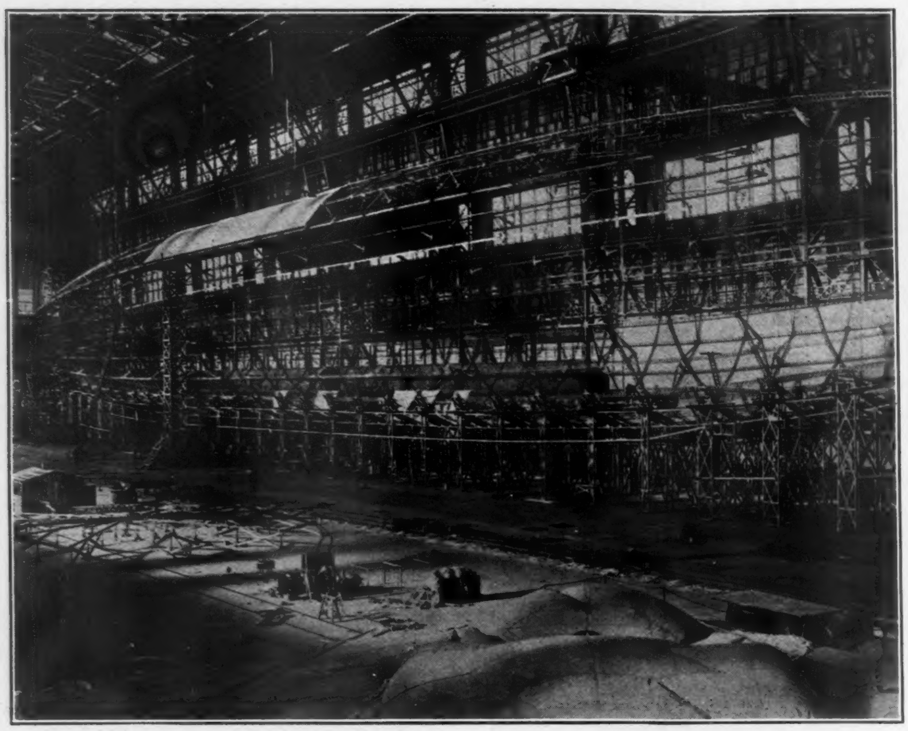
The skeleton of the dirigible is made up for the most part of latticed duralumin members which are triangular in cross section, and the longitudinal members of the framing are bound to a series of main transverse, circular frames or rings which are spaced about 33 feet apart. These rings are stiffened by a complicated network of diagonal wire braces; and midway between each succeeding pair of main frames is placed a frame of lighter section which is not braced with transverse wiring. Again, halfway between the main longitudinals are secondary longitudinals, and these are stiffened by their own system of wire diagonals. One



Hangar at the Naval Air Station, Lakehurst, in which the great ZR-1 will be housed between flights.



An artist's conception of how the navy's immense rigid airship will look while in flight.



The duralumin framework of the ZR-1 assembled and ready to receive the outer covering.

of the pictures accompanying this article shows in a striking manner the cobweblike character of the wiring and the complicated and seemingly delicate construction of the latticed frame members. Inasmuch as duralumin weighs only about one-third that of steel, it is not hard to realize that the whole of the hull framing does not weigh more than fifteen tons.

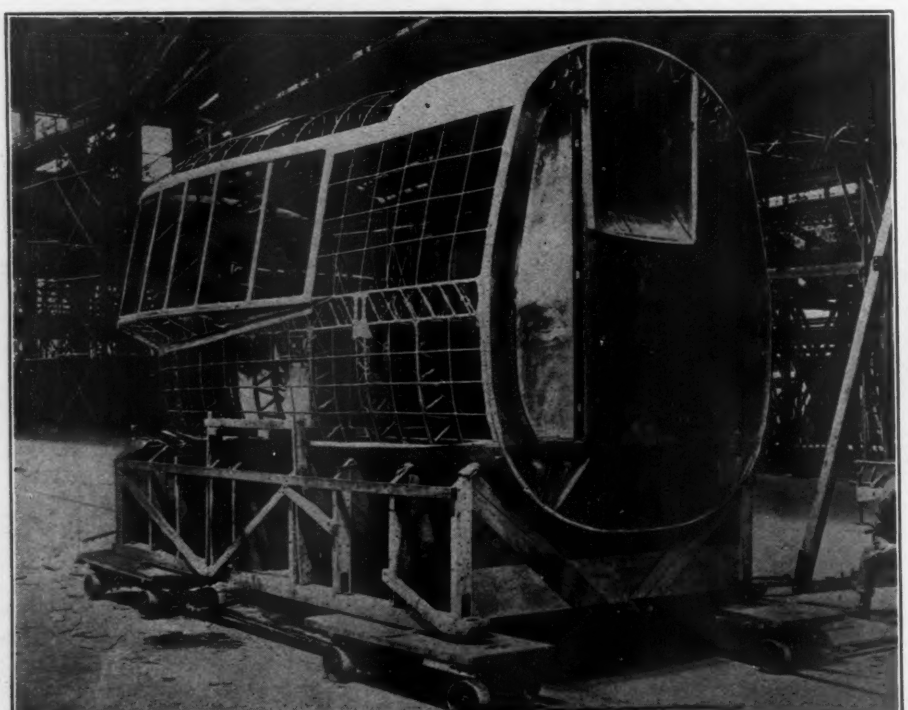
To add to the difficulties of fabrication, the duralumin was first rolled into thin sheets from which the multiple units were stamped and cut. In preparing these multiple parts, great exactness and uniformity had to be assured, and this was particularly the case in drilling rivet holes in interchangeable members. Without this precision there would have been a gradual accumulation of dimensional errors which would have led to serious irregularities and distortion of the framework during its assembling, section by section. The readers of the Magazine will be interested in learning that compressed air operated a special riveter in fabricating the latticed struts and also helped to function the automatic spacing table on which rivet holes were drilled in the strut channels.

Duralumin is a metal that must be handled with more than ordinary care in order to get the best out of it when in a finished state. For instance, it can be annealed and made comparatively soft by heating it from 30 minutes to an hour at a temperature of 662° F., and then by allowing it to cool slowly or to be chilled by quenching; and the metal may be tempered by heating it to 914° F. and cooling it. Duralumin will remain soft for an hour or more after tempering, but will gradually harden thereafter. Accordingly, the metal must be manipulated quickly following the softening treatment; and this peculiarity had to be taken into consideration in devising the manufacturing processes as well as the tools utilized in forming and in assembling the different structural units. Much ingenuity and engineering resourcefulness were displayed in creating these novel facilities. All rivets, which are also of duralumin, were tempered, and had to be driven before they began to harden. As each structural member was finished it was coated with varnish by means of a spray-painting outfit.

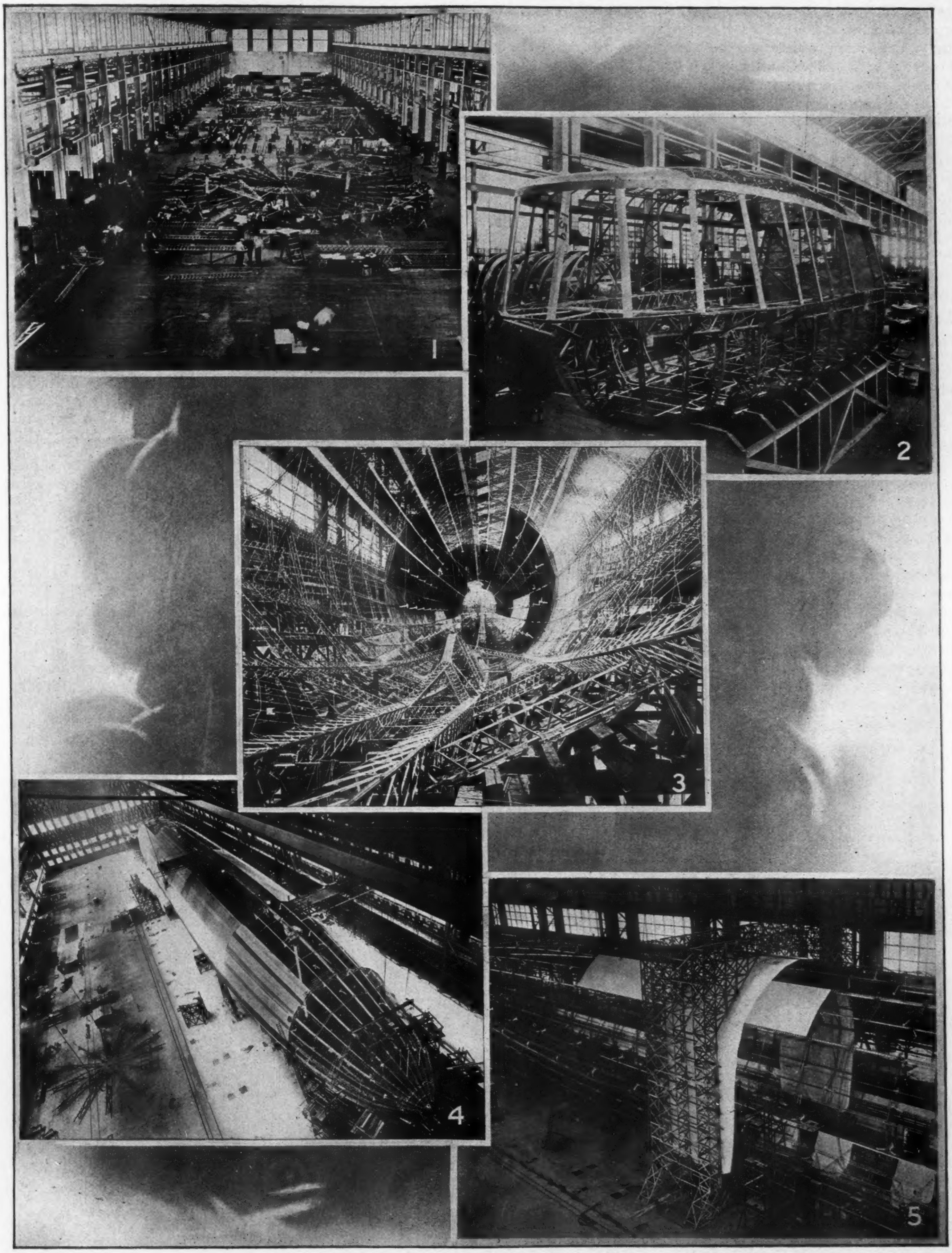
Each of the twenty gas bags, which give the ZR-1 her buoyancy, is held in place in its own cell by a restraining netting formed of ramie cord. Outside of this 9-inch mesh is a reinforcing network of tightly stretched wires. These wires produce an 18-inch mesh and are secured to the inner channels or members of the longitudinal framework and to the divisional, circular frames. This arrangement, in effect, amounts to holding captive within the skeleton of the dirigible twenty independent balloons. The gas bags are fashioned of goldbeaters' skin —the outer coat of one of the intestines of the ox. This material is highly resistant to the passage of gas.

The external skin or envelope of the craft is made up of a strong cotton fabric put in place in wide longitudinal strips bound by lacings to the underlying metal framing. The contiguous edges of neighboring strips are united by narrow cemented ribbons of the same fabric. The envelope is made weatherproof by a brush-laid surfacing of cellulose acetate.

The fuel tanks, of which there are 62, are placed in the deep keel that extends fore and aft for nearly the whole length of the dirigible, and about one-fourth of them are so hung that they can be dropped clear of the airship to lighten her in case of an emergency. The fuel is distributed to the different engines by aluminum piping; and a special aluminum alloy was used in casting the pipe fittings. These fittings, despite the care taken in their making, developed leaks when the line was subjected to test pressure; and the puzzling question was how to make these essential parts thoroughly tight. After much experimenting, water glass was found satisfactory when forced into the fittings under pressure. To prepare the fittings for impregnating, they were placed in a sealed tank which was evacuated by a vacuum pump. At the proper time, the silicate of soda solution was turned into the tank until it covered the castings, and then air pressure was applied to the liquid to force it into any pores in the fittings. A pressure of 300 pounds was maintained in this way for about an hour. When dried subsequently, the castings were found tight against gasoline at a pressure of more than 100 pounds—a pressure much in excess of that required to convey the fuel from the tanks to the engines.



Framing of the airship's control car as seen from the rear.



Official Photographs U. S. Naval Air Service.

Fig. 1—Fabrication of duralumin structural units at the Aircraft Factory, League Island Navy Yard, Philadelphia, Pa. Fig. 2—Framework of the control car viewed from the front. Fig. 3—How the ZR-1 looked inside during an early stage of her assembling at Lakehurst, N. J. Fig. 4—Looking down on the giant dirigible within her hangar when much of her envelope was in place. Fig. 5—A close-up of the bridge used in putting the dirigible's outer skin in place.

The six Packard engines which propel the ZR-1 are carried in a like number of gondolas or cars which are suspended from the underbody of the craft. Two of these cars are hung on the centerline, well forward and well aft, while the four others are disposed laterally amidships. The bow and the stern engines and one pair of the flanking motors are geared so that they turn their propellers at a lower speed. These motors are reversible, and are used for maneuvering and for driving the airship at her cruising speed. The propellers fitted to them have a radius of 17 feet 4 inches. The ungeared engines drive 12-foot propellers.

The crew of the ZR-1 numbers 30 men, and their living quarters are arranged on a platform built on top of the keel within the body of the craft. The dirigible is handled from the control room which occupies the forward end of the bow gondola. A telephone system extends from this control room to the other gondolas and to certain important positions within the envelope so that the commander of the airship can maintain vocal communication with any essential division of his vessel.

According to the naval authorities, the advantages of this type of craft are: its enormous lifting power; its large cruising radius; and its ability to travel for long periods at a speed three times as fast as that of the swiftest of dreadnoughts. In justifying the construction of rigid dirigibles, Rear-Admiral Moffett has said: "One of the reasons for developing airships which has actuated the Navy Department in this project has been their commercial possibilities, and the advantages that will accrue to American commerce and industry through their development." In conclusion, it should be emphasized that the United States is the only nation that has sufficient helium to supply the needs of a numerous fleet of airships. With any other buoyant gas the hazards are too great to offer much encouragement to the building of trade lines of passenger and cargo-carrying dirigibles.

Prize Contest Gives Drillers Chance to Show Their Skill

ONE OF a good worker's assets is reasonable pride in the tools of his trade. In many lines of industry the skilful toiler does not shine in public simply because the man in the street is unaware how the worker accomplishes results. This is certainly true of the men in those branches of industry that provide us with raw materials reclaimed from the bowels of the earth.

Recognizing the existence of this pride, and intent upon giving them a chance to show their skill, mining companies in Jerome, Ariz., staged a Fourth-of-July contest for drillers using pneumatic equipment. This competition was held at the local ball park; and the following details have been kindly furnished by Mr. H. A. Wright, Efficiency Engineer of the United Verde Copper Company.

The conditions under which the men competed were carefully prescribed and were to this effect:

Team—
To consist of one runner and one helper. Entrance fee, $10 for each team. Type of machine, Ingersoll-Rand No. 248 "Leyner" drill; type of bar, 3½-inch single-screw column with arm saddle and collar; type of air hose, 1-inch screw connection; and type of water hose, ½-inch screw connection.

Steel—
Two sets of steel will be on hand for each team. Cross bit, with a 20-inch change, will be used by all teams. Size of starter, 1⅞-inch, 30 inches long; size of second, 1 13/16-inch, 50 inches long; size of finisher, 1¾-inch, 70 inches long.

Bar and Equipment—
The collar will be fastened to the bar and set each time by the judges. The arm will be assembled, the saddle being separate from the arm, and the bar used will be a single jack bar 6 feet 10 inches long. The center line of the bar will be 30 inches from the rock. In oiling the machine, some oil must be poured into each one of the oil plugs. Water hose must be in one piece so that the end of the short connection can be screwed into the machine.

Method of Procedure—
All equipment will be lying on the platform 15 or 20 feet back from the rock. On receiving the signal, the drill runner and the helper will set up the machine, connect the hose, move the steel close to the machine, oil the machine, turn on the air, and start drilling. As soon as the air is turned on, the helper will step back and allow the machine runner to drill one hole 5 feet deep. The depth of the hole will be measured by a piece of tape wrapped around the finishing steel 5 feet from the edge of the bit. The machine runner will receive no help of any kind after the air is turned on.

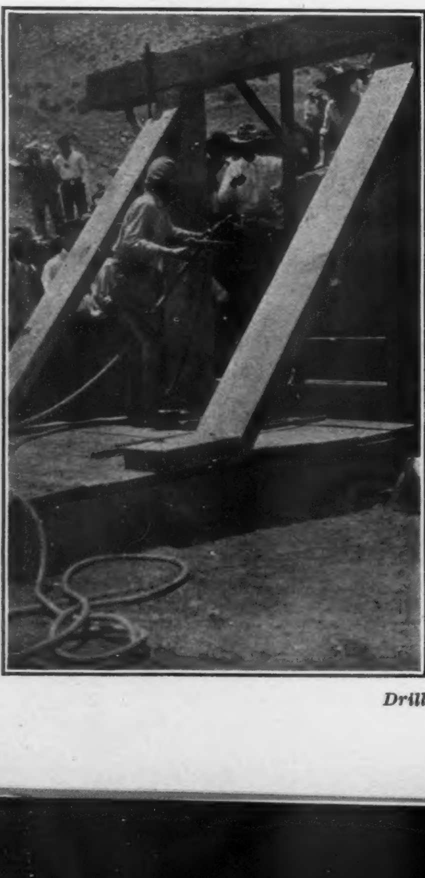
Prizes—
The prizes will be $200 for the first team, and $100 for the second team. In case there are more than three contestants, the prizes will be $200 for the first team, $100 for the second team, and $50 for the third team.

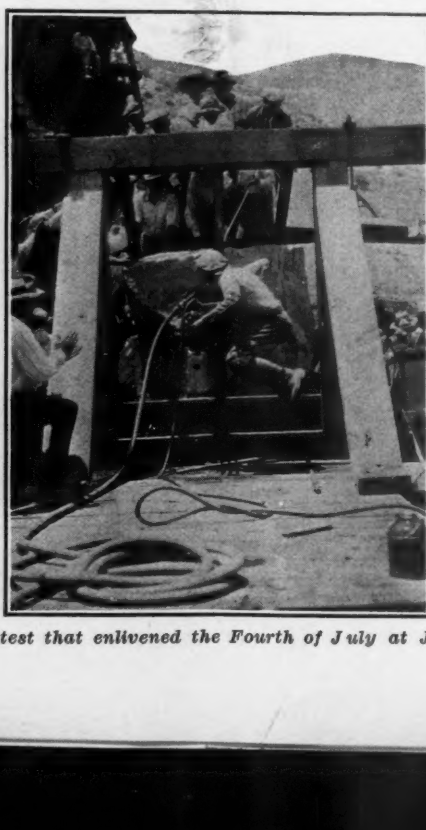
Committee—
Timekeepers, 3; 1 judge; and 1 gage man. Two air gages to be used. In order that the contest may be fair to all, the same machine and equipment will be used by the teams. Each team will supply its own steel. The team to drill first will be decided by drawing lots before the contest is started.

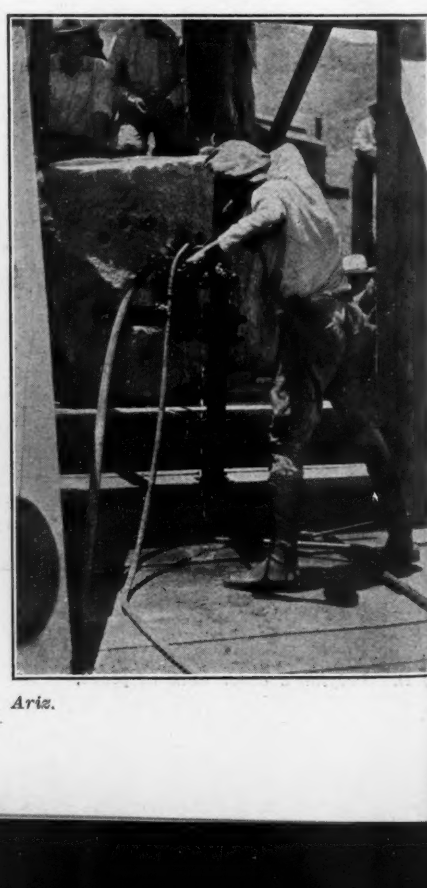
Four teams entered the competition, and their performances and their ratings are indicated by the accompanying table:

Entrants	Time to Set Up Min.	Time to Set Up Sec.	Total Time Min.	Total Time Sec.
Nanetti-Nava	1	46	6	41⅕
Lucero-Guiterrez	1	58	6	59⅗
Pini-Folena	1	44	7	54
Moraga-Molina	2	27	8	15

Allowing for the time taken in changing steels, the performances of the two leading teams, employees of the United Verde Copper Company, showed an actual drilling speed of 13 inches a minute. This agrees with the drilling speed attained in a similar contest which was held on July 4, 1920. Shop tests, carried out with the No. 248 "Leyner" drill prior to the competition last July, demonstrated that the machine hit 1,611 blows per minute, each blow being of 34 foot-pounds. The air consumption was 133.5 cubic feet per minute at a pressure of 100 pounds.







Drilling contest that enlivened the Fourth of July at Jerome, Ariz.

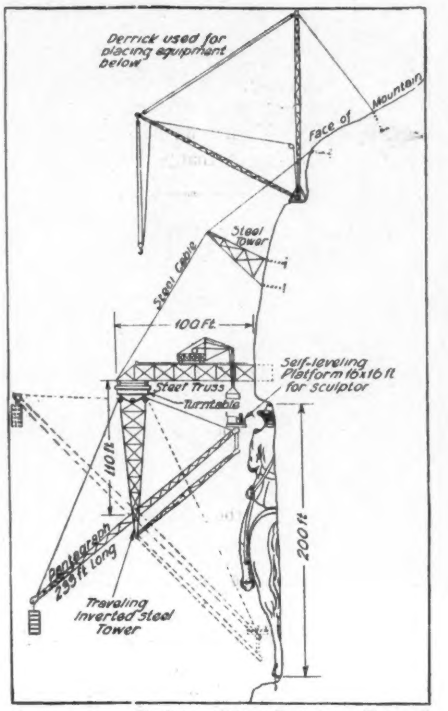
Carving the Great Confederate Memorial on the Face of Stone Mountain

By VERNON H. VANDIVER

STONE MOUNTAIN, on its northern side, drops in a sheer, naked precipice for almost 1,000 feet. A million years of erosion has marked it but slightly. Since the dawn of creation that rocky dome has stood as it stands today—well-nigh unchanged, imperishable. Such, indeed, is the impression made upon the gazer by this immense mountain of solid granite, whose foundation underlies half the State of Georgia. The bigness and the bareness of this unexplained work of creation fills one with profound awe, admiration, and reverence for the almighty hand of Him who made it.

Neither words nor phrases have yet been coined that can adequately describe this vast rock of ages. Facts and figures give but an inadequate idea of its austere grandeur. Stone Mountain, surrounded by level and rolling lands, rises 1,000 feet from its base. It is approximately 1½ miles in length, ¾ mile in breadth, and is solid granite without a seam, crack, or crevice in it. Forty years of quarrying at its southeast and southwest extremes has hardly nibbled its titantic mass: it has stood since time began, and time will not change it.

At the zenith of his creative flight, Gutzon Borglum, the world-famed sculptor, conceived the idea of a magnificent memorial to the Southern Confederacy—a memorial 1,100 feet long, 200 feet high, and cut into the side of Stone Mountain an average depth of 10 feet. A memorial, the figures of which overshadow in magnitude and grandeur every known sculptured figure of ancient, medieval, or modern times. A memorial, the central group of which alone would eclipse the Sphinx. A memorial dedicated not alone to the Southern Confederacy, whose traditions of heroism are a common American heritage, but which is to stand as America's supreme testimonial of the indissoluble union of the American people.

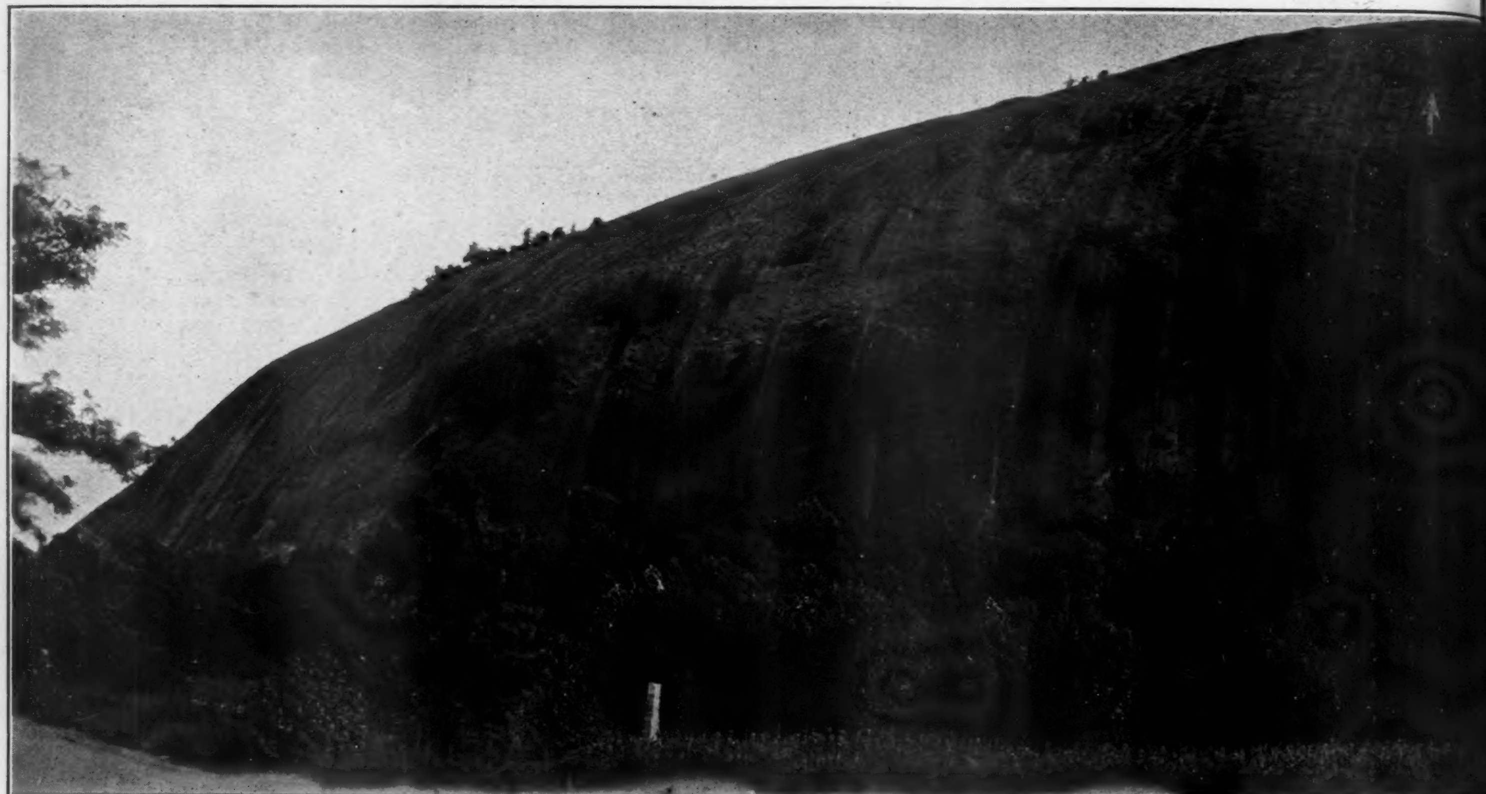


Courtesy Manufacturers Record.
Arrangement of the great pantographs which will make it possible for the sculptors, armed with pneumatic tools, to reach every part of the rock to be carved.

This great graven page of history will begin on the right near the mountain's summit, and upon it, sweeping downward and across it a distance of 1,100 feet, there will be carved a succession of groups representing the Confederate armies marching into battle. On the right will be artillery, the horses straining in their breeching to hold back the gun carriages. Next, will be cavalry in full swing. In the center will be cut a magnificent group of Confederate chieftains, including President Jefferson Davis, General Robert E. Lee, General J. E. B. Stuart, General "Stonewall" Jackson, and others still to be selected. On the left of this group and extending off toward the end of the mountain will be advancing Confederate infantry. General Lee's figure, in the central group, will be nearly 200 feet high, as high or higher than a 17-story office building. All other figures in this monumental work will be in relative proportion and in full relief. The ultimate impression upon the beholder will be that of standing just back of the central group and participating in the review of a passing army.

Below the military pageant there will be

The clay model of the central group of the memorial. In the middle is General Robert E. Lee, and at his right is President Jefferson Davis. On the extreme left is General J. E. B. Stuart, while on the far right is General "Stonewall" Jackson.

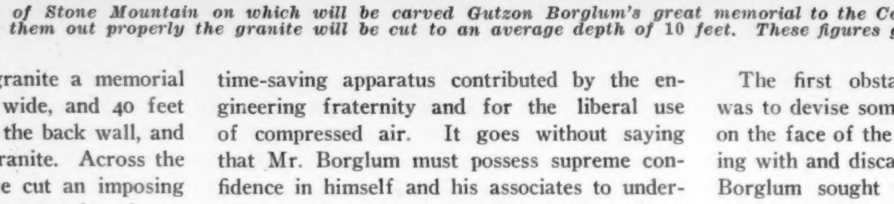


The northern face of Stone Mountain on which will be carved Gutzon Borglum's great memorial to the Confederacy. The white arrow indicates positio... feet high, and to bring them out properly the granite will be cut to an average depth of 10 feet. These figures give a suggestion of the colossal charac... of the w...

chiseled out of the living granite a memorial hall 160 feet long, 60 feet wide, and 40 feet high. The floor, the ceiling, the back wall, and the end walls will be solid granite. Across the front or outside wall will be cut an imposing succession of 13 windows, representing the 13 states of the Confederacy. Each window will have carved in its arch the name of the state for which it stands. In the center of this unique structure there will be a broad entrance reached by a magnificent flight of granite stairs rising from the base of the mountain, 100 feet below. Bronze tablets, to be placed within the memorial hall, will preserve the names of the men who fought for the Confederacy.

At the base of the mountain, to the right of the memorial hall, will be built an amphitheater of granite rivaling the dimensions of the Roman Coliseum. Here the precipice goes back in a recess which forms a natural sounding board of great capacity. An address delivered in this recess can be distinctly heard nearly a mile away.

So stupendous a work of art would be impossible of completion within the lifetime of its originator were it not for the ingenious labor and time-saving apparatus contributed by the engineering fraternity and for the liberal use of compressed air. It goes without saying that Mr. Borglum must possess supreme confidence in himself and his associates to undertake a project of such magnificent proportions; and it is equally true that he has that courage, that broad vision, and that singleness of purpose which is typical of all men who achieve greatness.



© Underwood & Underwood, N. Y.

A comparatively near view of a part of the face of Stone Mountain showing the white painted outlines of some of the figures of the central group. The outlines which look like delicate tracery are really twelve inches wide.

The first obstacle confronting the project was to devise some means of getting an outline on the face of the precipice. After experimenting with and discarding numerous schemes, Mr. Borglum sought the aid of Edward Porter, President of the Precision Machine Company, who developed a projecting machine capable of throwing a picture a distance of from 700 to 1,000 feet. A photograph of the clay model of the central group, fashioned by Mr. Borglum in his studio in Stamford, Conn., was then made, and from this an outline was reproduced on a plate measuring only 2x2½ inches. This outline, when projected on the face of the precipice, covered an area 200 feet high by 250 feet long. Ordinary workmen, suspended over the cliff at night, painted the outline. Seen from the ground, this outline looks like chalk marks, but in reality every line is 12 inches in width. The intense heat of the powerful light required for projection necessitated some method of keeping the plates cool to prevent their breakage. Compressed air was utilized for the purpose.

With the outline painted, Mr. Borglum was ready to begin the actual carving of the pano-

position of the platforms from which the various sculpturing apparatus will be controlled. The figures will fill a space 1,100 feet long and 200 of the work.

rama. On Virginia Day, June 18 past, with ceremonies befitting the historic and sacred occasion, Mr. Borglum was lowered over the cliff by means of a steel cable and, with a compressed air drill, began a work that will require six or seven years to complete. While it would be possible to execute the stupendous plan by suspending men by a series of steel cables from an anchorage on top of Stone Mountain, it would prolong the work beyond the sculptor's lifetime. Hoisting machinery of unique design and exceptional dimensions has, therefore, been developed to expedite operations.

Numerous steel trusses, anchored in the side of the mountain and held by strong steel cables, will support an inverted railway on which will travel inverted towers carrying 233-foot pantographs provided with counterweights on one end and self-leveling platforms on the other. Each platform will be 16 feet square; will carry a motor-driven air compressor and 10 or 12 sculptors with pneumatic stone-cutting tools; and will have a vertical working range of 200 feet. Along the tops of the trusses will run a track carrying a traveling crane for the purpose of transporting men and tools, and for removing stone as it is cut out. In addition to its vertical and lateral radius, each pantograph, by reason of an ingenious turntable at the apex of its inverted tower, will have a horizontal radius perpendicular to the face of the precipice. The turntable will permit the platform to be swung half a revolution if necessary, so that the platform can be drawn away from the face of the cliff any desired distance. All movements of the pantographs will be controlled by operators on the platforms.

Before any of the fine carving can be done on the panorama, it will be necessary to channel the outline of each figure and to remove the superfluous granite. This will entail many miles of channeling and the disposal of hundreds of thousands of cubic feet of granite. The channels will have to be cut an average depth of ten feet; and to do this by drilling and broaching would be a slow and tedious process. Though no known channeling machine is light or portable enough for the work, Mr. Borglum feels confident that the engineering fraternity will develop some form of sand blasting which may be easily controlled and which may also be counted upon to speed up the work. When the channeling is done, the superfluous stone will be broken out by the well-known plug-and-feather method. No explosives will be used.

Mr. Borglum, with a pneumatic drill, being lowered over the face of the precipice to drill the first hole in the monumental undertaking.

With the rough outline of the figures standing out in full relief, Mr. Borglum will be ready to put an army of sculptors to work, placing them under the direction of his students and himself. Each student, with his crew, will work on the figure assigned him until it is finished, and will have as a guide a model one-fifth the actual size. The model will be suspended along the face of the precipice, and every

dimension will be calipered. The modeling of the figures will, in itself, be an enormous task. Mr. Borglum will require for the purpose a studio many times larger than any ever before used by a sculptor. He will need hundreds of tons of clay and of the other materials peculiar to his art. Stone Mountain will be modeled in sections, one-fifth actual size, across the end of his studio, and the figures will be developed on it. Impressions will then be taken and models cast for the final work. When the panorama is completed, work will begin on the memorial hall and the amphitheater, which, by comparison, will be simple undertakings, requiring but a few months to execute.

On Virginia Day, June 18, actual work on the memorial was started with befitting ceremonies. Mr. Borglum, in working garb, is seen shaking hands with Governor E. Lee Trinkle, of Virginia, and in the center immediately back of them stands Governor Thomas W. Hardwick, of Georgia.

When the whole project is finished, the hand and the ingenuity of man will have done that which time could not do. It will have changed Stone Mountain: it will have made it the eighth wonder of the world. God created Stone Mountain. Man is about to create upon it the most imposing example of art the world has ever produced—a gigantic memorial to a great though lost cause. This immense deposit of granite has life, as much so as a tree has life; and though a detached block of it exposed to the elements will disintegrate and crumble in about 150 years, nevertheless "our heroes carved in stone," fed by the life sap of Stone Mountain, "will stand on guard, custodians of imperishable glory, sentinels of time." None but God can destroy it.

CARBON DIOXIDE RETARDS BUTTER DETERIORATION

A NEW METHOD of butter manufacture is now being tried in Holland and is reported to be meeting with considerable success in delaying the deterioration of butter, which is always a big problem in shipping. Whether shipped in tubs, casks, boxes, or tins, the merchandise rarely arrives at its destination in a condition that corresponds to that in which it left the creamery or the cold-storage warehouse.

The new process consists in churning the cream in an atmosphere of pure carbon dioxide. The air is sucked out of the churn and is replaced by carbon dioxide, which fills the pores of the butter and keeps out the oxygen as long as the butter is not vigorously agitated after exposure to the air. The natural process of deterioration is accelerated by oxygen and by any temperature above the point at which the butter fats congeal and close up the minute spaces into which oxygen can penetrate and produce reactions. The consumption of carbon dioxide is said to amount to about 1.1 pounds for every 1,100 pounds of butter; and its cost, together with that of the process, is considered negligible in view of the advantages gained.

CUTTING AIR-PORT LENSES WITH SAND BLAST

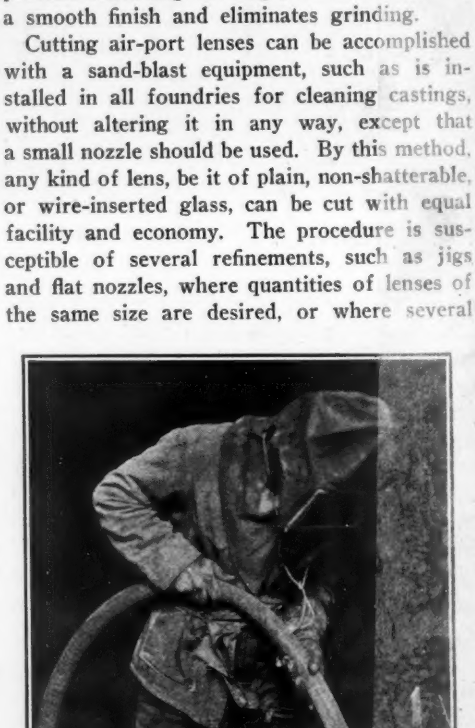
THERE RECENTLY arose at the Navy Yard, Charleston, S. C., the problem of supplying deadlight lenses for certain work on one of the vessels undergoing overhauling. There were a number of lenses on hand, but none was of the size required for this special job. Several attempts were made to cut down lenses by scribing them on both sides with a diamond cutter; by breaking and chipping off the edges; and then by grinding down to a smooth finish.

The old method of grinding down the lenses on an ordinary emery wheel under water was also employed, but this proved too slow where there was considerable grinding to be done. It was only after various unsuccessful attempts of this kind were made—which resulted in more broken than good lenses—that a satisfactory solution of the problem was found in the sand blast as the cutting medium.

The lenses in question were of non-standard size, being 1 inch thick and 6¼ inches in diameter. They were urgently needed; and, with the sand blast, were readily cut from lenses of larger size at a saving. An accurate account of the cost of the work showed that five lenses were cut at a total outlay of $4.50, while the average time consumed in assembling and in cutting one lens was about ten minutes.

The glass to be cut is first covered on both sides with pieces of paper or cardboard, preferably the latter, over which are placed steel or cast-iron disks of the required size. All of these are then held together with an ordinary screw clamp. In fitting the disks, care should be taken to have them perfectly level, inasmuch as the lens will crack in the cutting operation if they are not level. When cut half through, the lens should be turned over and cutting continued from the other side. This tends to prevent concaving the edge, and thus renders a smooth finish and eliminates grinding.

Cutting air-port lenses can be accomplished with a sand-blast equipment, such as is installed in all foundries for cleaning castings, without altering it in any way, except that a small nozzle should be used. By this method, any kind of lens, be it of plain, non-shatterable, or wire-inserted glass, can be cut with equal facility and economy. The procedure is susceptible of several refinements, such as jigs and flat nozzles, where quantities of lenses of the same size are desired, or where several



Cutting the deadlights of air ports by means of sand blast. The photograph was taken when the reduction of the diameter of the glass disk was partly completed.

lenses are to be cut from the same piece of glass.

A very marked advantage in the use of the sand blast for cutting lenses, and one that will prove its worth in dollars to any concern employing it, is that chipped lenses, which otherwise would be a total loss, can now be salvaged by cutting them down to the next smaller size.

Savings Made Possible by Efficient Service in the Field

What the Experience of a Great Producer of Pneumatic Equipment Has Revealed

By A. S. TAYLOR

ECONOMY OF EFFORT, the reduction of lost motion in industry are factors that nust play a larger part in our productive life if the cost of living is to be lowered and we ire to be placed in a position to compete on nore nearly even terms in the markets of the vorld.

The public at large little realizes how spendhrift we are of our time, our money, and our raw materials; and it is this lack of general understanding—often indifference—that explains vhy as a people we go on squandering our ubstance while complaining loudly of the bill e have to pay.

About two years ago, the Federated Amerin Engineering Societies, through the Comittee on Elimination of Waste in Industry, iade a reconnaissance report which brought o light the costly lost motion, the waste prevalent in five of our departments of industry. The activities investigated had to do with the nanufacture of men's clothing, the manufacture of boots and shoes, the fabrication of xtiles, printing, and the metal and the buildg trades.

The experts engaged in that research did not hesitate to say that hundreds of millions of lars were yearly wasted which could, for the ost part, be saved through the exercise of easonable prudence, foresight, and the employment of proper administrative and operave methods. The six lines of endeavor nalyzed are but a few of the multiple branches of our entire industrial life, and in the main they have to do with the utilization of materials which have already been brought to rarious stages of finish. The Committee did not study any of the great basic fields of effort that have to do with the production of those raw materials which are mined or quarried from the bosom of the earth.

It is more than likely that the Federated American Engineering Societies will, at the first opportunity, have the Committee on Elimination of Waste in Industry direct its attenion to mining and to quarrying which provide us with coal, iron, copper, zinc, and other ndispensable metals as well as with building tone and a wide range of needful non-metallic ainerals. These raw stuffs of Nature's making ay properly be termed the very backbone of r industrial life—the foundation upon which sts all our vast and varied manufactories.

In a general way, the consuming public knows t most of the raw materials recovered from e earth's crust are obtained primarily by illing and blasting them loose, but beyond is the average man in the street knows little anything. And yet the price that must ultitely be paid for these essentials is largely ermined by the measure of efficiency or the k of it displayed in using the tools required the work. As a matter of fact, a tremenus amount of helpful, educational service can be done among miners and the like which will bring in rich rewards to everyone concerned.

The pneumatic rock drill has worked wonders in the field of mining—using this term in its very widest sense; but this does not mean that there is not much to be learned by those who are actively engaged in operating and in maintaining tools of this sort. A great deal of engineering skill has been devoted to the development of the air-driven drill so that it will function effectively under a wide range of service conditions; but the successful and the efficient performance of such a piece of machinery must, in the last analysis, depend upon how it is treated by the man who runs it. The operator must be taught something of the structural limitations of his drill and be made to understand that he cannot ignore certain rules and then expect the tool to do its best. It is logical that the first cost of these labor-saving devices should be comparatively high; but this outlay is soon covered and a handsome return made whenever the drills are capably and understandingly used, for with them it is practicable to do far more work in a given period than could possibly be accomplished by the same number of men relying only upon hand methods.

SUPPLEMENTING manufacturing excellence with service in the field is an industrial development which is rapidly gaining in importance. The value of this coöperation between the producer and the user of labor-saving mechanical equipment has been recently emphasized by Mr. J. H. Jowett, Vice-President and General Manager of the Ingersoll-Rand Company.

Mr. Jowett, a short while ago, made a tour through some of the great mining sections of the country. In the accompanying story he shows the superior results obtained with the pneumatic rock drill where the operators had been carefully trained by field service men. The article illustrates how service of this sort may lead to economies amounting to many millions of dollars annually.

The oldest company in America engaged in the manufacture of power-driven drills and other mining equipment has, for years, made it a practice to keep in close touch with mining men in order to give them a service which would aid them in meeting the diversified problems of their field of effort. The interest of this company has not ceased with the selling of its apparatus—it has been just as much concerned about their subsequent performance; and this has led to the organization of a unique force which covers the whole country and follows carefully what the tools are doing in the hands of the purchasers. Not only that, but the activities of these service men are surveyed every now and then by some of the executive officers and the technical experts of this great engineering corporation.

In carrying out this policy of bringing the company's administrative and manufacturing departments directly in touch with the miner, several of its officials recently made an extended trip through a number of the western states for the purpose of speeding up service through a first-hand study of the situation. The party was made up of Messrs. J. H. Jowett, Vice-President and General Manager; William Prellwitz, Chief Engineer; and Frank Carroll, General Western Representative—all of the Ingersoll-Rand Company. As Mr. Jowett has expressed it: "Service has put our business where it is; and at every place visited by us our first question, after the usual exchange of civilities, was, What can we do for you? Our contacts were with the men engaged in every phase of mining from those at the very headings far below ground to those in charge of the different departments at the surface. We learned a lot from many of them; and two of us, at least, brought home a mass of notes which we shall digest at leisure and profit by in numerous practical ways. Much of the wastefulness in mining, to which the Bureau of Mines has called attention from time to time, can be very substantially reduced through the adoption of simple, corrective measures.

"Rugged as the up-to-date pneumatic drill is, and capable as it is of driving a steel through any sort of rock, nevertheless it is a piece of machinery that calls for a good deal of understanding care. Not only that, but if a proper measure of care and attention is not given it, the drill will require more than the normal amount of repairs. The pneumatic drill is a striking example of the adage, 'A stitch in time saves nine.' Further, its career in a mine emphasizes the well-known but often neglected fact that it costs money to move anything any distance, no matter how short. And this brings us to that outstanding problem—proper service.

"In certain of the more progressive mines, and on tunnel work generally, it is the custom to carry the rock drills back from the heading to some convenient point underground at the end of every shift so that the tools can be examined, overhauled, cleaned and oiled ready for the next shift. In this way, minor shortcomings can be detected and corrected promptly and the drills quickly made fit again for use. The expense involved is trifling compared with

that entailed when drills are taken all the way to the surface and there turned over to the repair shop. In other words, frequent inspection underground offsets a rather common tendency on the part of the drill runner to carry on with a defective or limping tool until the machine is put out of commission because of a really serious breakdown.

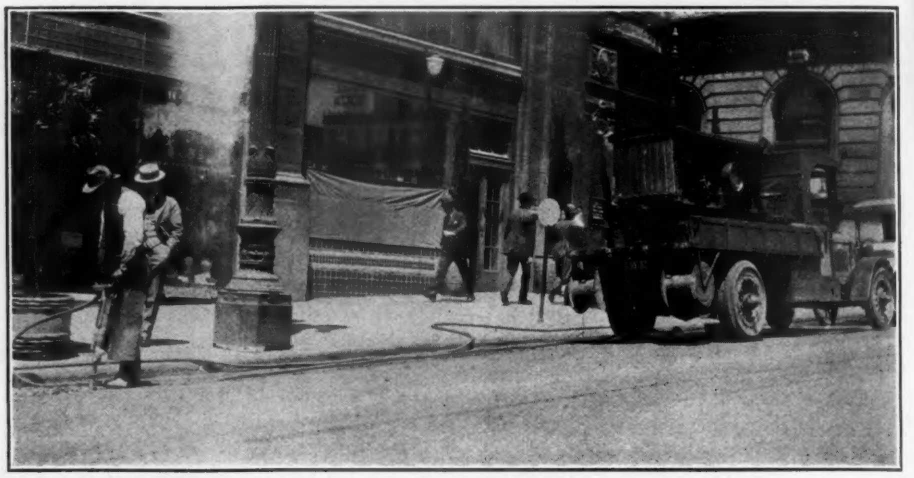
"And right here it is well to stress the importance of frequent and proper lubrication of rock drills. From the very nature of the service expected of such drills it should be plain that the wear and tear of moving parts can be kept lowest only by seeing to it that all neighboring sliding or rotating metal surfaces carry a suitable film of oil; and experience has shown that a certain grade of lubricant, familiarly known as 'liquid grease,' is especially suited to the needs of rock drills. Indeed, it has been found that drills so lubricated at frequent intervals by their runners will stand up to their work for six months or even more than a year without requiring any attention at the repair shop. How to lubricate rock drills is one of the things the service man teaches.

"Of course, it is not possible to give drills 'the once over' at the end of every shift unless men trained for that work are at hand. This schooling is part of the duty of the service men that we keep continually in the field; and it is probably not an overstatement to say that our company gives many dollars' worth of service with every drill it sells. The ultimate value of this service can hardly be estimated; and operating officials familiar with it prize it highly inasmuch as they are better able than we are to appraise the resultant benefits. Naturally, the service man knows the pneumatic drill thoroughly and is fully alive to just what it can do and what should be expected of it under any condition in practice.

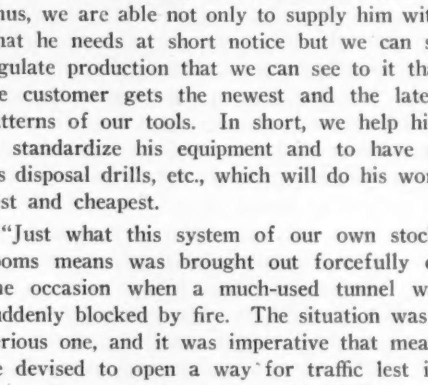
"A good many mine operators have yet to learn that a great deal of money can be saved by keeping a sharp eye on the scrap box. All too often a perfectly sound drill part is discarded when a reasonable amount of familiarity with the tool and intelligent scrutiny would have revealed the part that was causing the trouble and which should have been scrapped instead. Mark you, these drills are manufactured by repetitive processes which make the component parts interchangeable. Therefore, no part of these tools should be thrown aside until it is known to be worn out. More than once, our service men have coöperated with the repair-shop boss in a friendly wager that a saving of 20 per cent. was possible in tool up-keep. They have invariably made good; and this has been accomplished largely through watching closely what went into the scrap box. Nothing that could be utilized was cast aside.

"And this brings us to another phase of service—that of seeing to it that the customer obtains replacements with dispatch and whenever they are needed. A very common practice with many big mining operators and engineering contractors is to carry in their own storerooms large quantities of reserve equipment. Apart from the overhead, which must be paid for sooner or later, insurance, and the cost of maintaining storage facilities, this procedure has often found the owners overstocked with certain tools and parts. Recognizing this, we have devised a system by which we do the storage work either at our main plants or at our outlying branches, and these stocks are kept up in accordance with an intimate knowledge of the changing needs of each customer. Thus, we are able not only to supply him with what he needs at short notice but we can so regulate production that we can see to it that the customer gets the newest and the latest patterns of our tools. In short, we help him to standardize his equipment and to have at his disposal drills, etc., which will do his work best and cheapest.

"Just what this system of our own stockrooms means was brought out forcefully on one occasion when a much-used tunnel was suddenly blocked by fire. The situation was a serious one, and it was imperative that means be devised to open a way for traffic lest inconvenience and losses be suffered by merchants and a heavy drop in revenue result. The management called on the Ingersoll-Rand Company to save the day; and inside of two hours there were dispatched to the seat of trouble four portable air compressors, two pneumatic drill-steel sharpeners, numerous drills, sets of drill steels, etc. The next morning, the men sent with that outfit were at work; and inside of eight days they had drilled and blasted a way around a cliff and had opened a route which sidestepped the obstruction."



A mobile plant which furnishes compressed air for the operation of two pneumatic paving breakers.



This is the hand method of pavement breaking which has held sway until the development of suitable air-driven tools.

PNEUMATIC PAVING BREAKERS RUSH REPAIR WORK

TIME and again, it has been brought home to the hastening citizen, whether afoot or in carriage, that the public was inevitably inconvenienced whenever the tide of traffic was interrupted or slowed down by improvements or alterations which necessitated the digging up of busy thoroughfares. Indeed, it is a matter of concern to those persons responsible for the security of property—especially against the ravages of fire—whenever the prompt and rapid movement of fire-fighting apparatus is obstructed in the least degree.

Owing to the development of pneumatic tools it is now possible to dig a trench in a street to replace the earth—tamp it firmly; and to restore the roadway surface to its normal smoothness in rapid order. Further, these new aids to fast work enable the repairmen to carry on their jobs with a minimum of interference to travel. As an example of what can now be done with the facilities available, we might cite the case of the Pacific Gas & Electric Company in San Francisco.

That public utility has abandoned the long-familiar pick and shovel for digging up streets; and recently opened up trenches with pneumatic paving breakers drawing motive energy from an Ingersoll-Rand portable air compressor. The object of the digging was to make repairs to certain underground mains. The record shows that two men, each operating a paving breaker, were able to dispose of 300 feet of pavement in the course of a working day. A third man was in charge of the compressor, which was carried on a large motor truck and was bolted to heavy timbers resting directly on the bed of the vehicle. Two large metal drums, hung under the bed of the truck at the rear, formed reels on which the air hose was wound when not in use.

According to a report of the Rubber Association of American, 146,167,791 pounds of crude rubber was used in the manufacture of tires and tire accessories in the second quarter of the present year, while less than a fourth of this amount, 34,252,502 pounds, was used for all other purposes. The total sales value of the automobile products was $142,818,771.

Making a Success of It in the Cement Industry

Career of the San Antonio Portland Cement Company a Fine Example of What Can Be Accomplished Despite Heavy Odds

By CHARLES BAUMBERGER*

HOW did he make a go of it? How did he win out when so many were certain that failure would be his only reward?

These are human interest questions which crowd to the forefront for answer whenever a man's achievements mark him apart from his fellows.

Half a century back, there was but a single mill in this country engaged in the manufacture of cement. At that time nearly all of what little cement we used came from Europe. Today, we have scores of large plants industriously turning out this adaptable and indispensable building material.

The accompanying story, prepared by a pioneer in America's cement industry, should, therefore, prove doubly worth while because it recites not only the ups and downs of the early days of the business but also reveals much that has contributed to the narrator's success in his chosen field.

The author shows that readiness to utilize the fruits of engineering progress is a prime factor in forging ahead in industry, for, in addition to promoting economy and efficiency, it gives the alert man a commanding lead over his less progressive competitors.

THERE WAS a time when the belief prevailed widely that Portland cement had to come from England where the outcropping of so-called Portland rock made the manufacture of cement a supposedly local industry. That erroneous understanding was a handicap to the early American cement producers; and it took some years to convince the public at large on this side of the Atlantic that Nature had also furnished us with abundant raw materials from which cement of the highest quality could be made.

For those who may be unfamiliar with the subject, let it be said here that natural cement rock is nothing more or less than a limestone carrying a requisite amount of clay; and this rock, when properly treated, forms the basis of the cement which is used so extensively in building undertakings today. The following story brings to light how an accidental discovery—as has so often been the case—led to the creation of the first cement plant in the United States west of the Mississippi River.

In 1879, an Englishman of the name of William Loyd, while hunting within the northern corporate limits of the City of San Antonio, Tex., happened upon quarries belonging to the muncipality and there discovered a blue argillaceous limestone which he thought he recognized as cement rock. Taking a piece of the rock back to town with him, Loyd sought advice lest he be mistaken in his conclusion. He turned his sample over to Mr. George H. Kalteyer, a graduate chemist. The latter, after making an analysis, pronounced the material natural cement rock containing about the correct proportions of lime and clay to make a true Portland cement.

Thus encouraged, Loyd interested W. R. Freeman, a hydraulic engineer; and together, in a small way, they made some experimental burns from that rock. Having but limited means, however, they turned to Mr. Kalteyer for both financial and technical assistance. Out of that association grew the idea of incorporating a company to manufacture hydraulic cements; and, accordingly, the Alamo Portland & Roman Cement Company was organized under the laws of Texas on January 15, 1880. The capital stock amounted to $3,100, divided into 124 shares having a par value of $25 each.

The original incorporators were William Loyd, George H. Kalteyer, B. J. Mauerman, F. V. Weise, and W. E. Jones. The author took care of the books of the company at that time for the modest remuneration of $10 a month. That sum to a lad of seventeen was not as small as it looks now. In 1884, opportunity gave me the opening I earnestly desired, and I was made manager of the plant. But don't let us anticipate our story.

As an outcome of the formation of the company, there was constructed an intermittent pot kiln; and the associate buildings were small and of lumber. The mechanical outfit consisted of a small Blake jaw crusher, a pair of rolls, and a vertical French burr mill. Power was supplied by an unpretentious slide-valve engine, the flywheel of which was composed of a cast-iron rim and wooden spokes. The plant was capable of grinding about ten barrels per diem; and, as there was no American standard to guide us, we tried to follow the European practice and ground to a fineness of 5 per cent. residue on a No. 50 cloth. It might be well to state here that all the cement was bolted and that the rejection from the bolt went back to the burr mill.

The mill building had three floors: a ground floor, where we had wooden bins and where the cement was stored after it was seasoned; and two floors above where the seasoning was done by spreading the cement in layers varying in thickness from six to nine inches. The cement, while seasoning, was aerated by turning it over with shovels once a week and by testing it from time to time until it satisfied the soundness test. This test was made much in the same way as it is carried out now, but in those days we were ignorant of the boiling test and depended entirely upon the cold-water test to determine soundness. No wonder, we occasionally shipped "green cement." The plant was located close to the quarries but fully three miles distant from the nearest railroad. This was a handicap, because all fuel had to be hauled to the mill and the finished product similarly transported to the city.

The outlook as many of our acquaintances saw it was not a promising one, and we had our full share of Job's comforters. The county poorhouse was then located adjacent to the mill, and we were often jokingly reminded, "Well you're right next to the poorhouse, and there should be consolation in the thought that you won't have to go far when the venture fails."

The burning of the cement rock was done by making alternate layers of fuel and rock—the fuel being coke. It took about a week to burn a kiln, and the result was something like 120 barrels of cement. The output of the kiln, after burning and cooling, was hand-picked; and that portion which clinkered was classed as Portland cement while the remainder was used for making natural or so-called Roman cement.

The quarry overburden was limestone containing from 10 to 15 per cent. of clayey matter. Upon burning, this material produced a hydraulic lime; and the stuff helped to pay for removing the overburden in order to get at the cement rock. In fact, the company found it necessary to engage in the lime business and in the sale of building stone so that it might eke out a precarious existence. However, the tide turned favorably before the end of the second year, and we had reason to believe that we had not undertaken to carry through a forlorn hope.

Before 1881 came to a close, the business had grown sufficiently to warrant erecting another kiln, and on the 1st of December of that year

*President, the San Antonio Portland Cement Company.

the capital stock was increased to $10,000—each share being valued at $25. The charter was then amended to read "Alamo Cement Company." The sales of our product had assumed what seemed to us enormous proportions, that is, 1,000 barrels a year; and our commercial enthusiasm was such that we deemed ourselves the foremost producers in the world. Texas was not then as interested as she is now in what outsiders were doing—her industrial horizon was a comparatively limited one.

A corner in the beautiful sunken gardens at San Antonio, Tex., on the site of the quarry which furnished the rock for the first cement manufactured west of the Mississippi River.

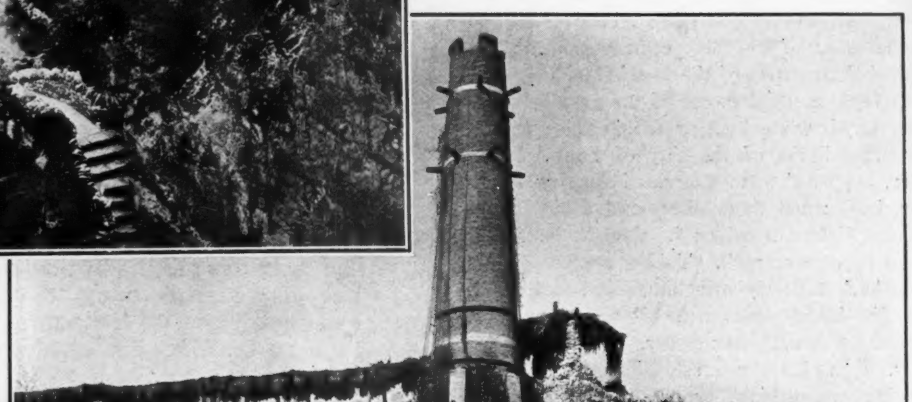
Forty-two years ago we charged $18 a short ton for Roman cement and $22.50 a ton for Portland cement, in bulk. The gross weight of a barrel of Roman cement was 300 pounds, and the similar weight of a barrel of Portland cement was 400 pounds. We charged $3.25 for the Roman cement and $5 for the Portland cement, in cooperage. No attempt was made to put up the cement in sacks of uniform weight for shipment, and a bag might weigh anywhere from 150 to 250 pounds.

Our main business was in lime and building stone, and we burned cement only occasionally: the same kilns being used for burning both the cement and the lime. Owing to the fact that we were not able to induce contractors to use our cement in laying sidewalks—indeed, experienced difficulty in marketing our product, we were forced, in self defense, to go into the sidewalk business so as to find an outlet for our surplus. As an aid in promoting this departure we obtained the right to use in the State of Texas what was known as the "Schillinger patent." The Schillinger patent covered the process of subdividing concrete sidewalks and floors into blocks for the purpose of controlling expansion and contraction. The right cost us $1,000; but the money was well spent, because we were able to collect a royalty on all sidewalks constructed in that manner in the state. To those who used our cement the royalty was at the rate of two cents per square foot, while the charge was five cents per square foot when foreign cement was employed.

The sidewalk business was not a source of unmixed satisfaction. As already mentioned, the cold-water test was our only means of determining soundness, and every now and then we utilized unintentionally unsound cement. As a result, a sidewalk, after being down several days, would occasionally bulge and swell by reason of the expansive force of free lime. Our particular concern was to deal with this situation before it attracted general attention; and more than once in the dead of night we tore up the work and replaced it as quickly and silently as possible. Our practice was to cover the walks with planks for protection, and to water the concrete twice a day—making observations at the same time by lifting the boards. This procedure gave us a chance to note what was going on without exposing our work to public gaze.

Back in the "eighties," General Q. A. Gillmore, then a lieutenant-colonel of engineers in the United States Army, was a recognized authority because of his well-known book, *Hydraulic Limes and Cements.* Inspired by the desire to win wider confidence in our product, we prevailed upon the mayor of the City of San Antonio and the municipal engineer to take at random from our stock samples of Portland cement and Roman cement; to put them under seal; and to send them to General Gillmore to be tested for both tensile and compressive strength. This was in May of 1881; and the report by that officer was highly commendatory. Thereafter, business grew steadily better.

By 1889, the demand for cement had increased sufficiently to justify the company in making further improvements. We built an upright shaft kiln of the Schoefer type, and ground the raw material first on French burrs or millstones, adding water, and then passed it through



All that is left of the original Schoefer Kiln of the Alamo Cement Company, now a picturesque feature of Brackenridge Park.

a pug mill. This mud was next made into bricks and the bricks were put on pallets and conveyed outside for air drying. After drying, the bricks were fed into the kiln for burning. This procedure proved economical in fuel consumption, for we were able to burn Portland cement clinker with 15 per cent. of bituminous coal and to produce an average of 50 barrels daily. The method was continued until 1897,

when still other improvements were given consideration. At that date, the rotary kiln had been adopted by the leading plants located in the Lehigh Valley of Pennsylvania; but we had no oil in Texas at that time, and none was discovered until four years later. Our problem was, therefore, to find a way to use the rotary kiln but with some other fuel.

From a German publication we learned that powdered coal was being successfully fired under boilers, and it occurred to us that possibly the DeCamp system might also be utilized

Another view of the sunken gardens in Brackenridge Park, San Antonio, showing the old kiln of the Alamo Cement Company in the middle distance.

in rotary kilns. Mr. Kalteyer went to Europe and while there purchased one of the DeCamp apparatus as well as a mill for grinding coal. Unfortunately, he died in August of 1897, shortly after his return to the United States, and the task of carrying out the plans fell to the writer. We bought a 50-foot rotary kiln from W. F. Moser & Son of Allentown, Pa.; and we were able to burn Portland cement with powdered coal until 1901 when, upon the discovery of petroleum in Texas, we adopted fuel oil.

The demand for our cement had so increased by 1908 that the old mill was no longer able to satisfy the market; and for various reasons we decided to abandon the original site and to relocate on a larger scale where we would be in close touch with the railway. As part of the scheme of expansion, the company changed its name and was incorporated as the San Antonio Portland Cement Company. As previously mentioned the writer entered the service of the original company in October of 1880. Ten years later he became secretary, in addition to exercising the office of manager, and in 1897, upon the death of Mr. Kalteyer, he was made president.

A sidewalk laid in San Antonio in 1883 with "Alamo" cement. The fine quality of the material is evidenced by the present appearance of the walk.

Notwithstanding the fact that petroleum was to be had in Texas in 1911, when the company was brought face to face with the need of considerably amplifying its power plant, still this fuel was by no means as cheap as Texas lignite which could be delivered at the works for $1.50 a ton. The utilization of either bituminous or anthracite coal was out of the question because of the high prices of those fuels. Therefore, the problem was to find a satisfactory way to use the native lignite.

About that date, the Smith Gas Power Company of Lexington, Ohio, developed a lignite-coal gas producer which, in connection with the producer gas engine, offered an economical solution of the prime-mover problem. Accordingly, the San Antonio Portland Cement Company decided to install an equipment of that nature. That outfit was composed of a 4-cylinder, 21½x24-inch Rathbun vertical gas engine, developing 500 H. P. at 200 R.P.M., and of Smith gas producers. Mr. H. O. Rinehold was in charge of the erection of this plant, and after completing that work he continued on as operating engineer. In 1912, the cement company purchased additional gas producers and another engine of the type and size just described. These engines were directly connected to 3-phase, 60-cycle, 480-volt Crocker-Wheeler generators. As a result of the excellent performance of the gas engines, a third unit of the same make was purchased in 1913. That machine had 8 cylinders of 21½-inch bore and 24-inch stroke; and at 200 R.P.M. it developed 1,000 H. P. The engine was directly connected to a General Electric generator. Mr. Rinehold became chief engineer and operated the power plant until 1920, when he was made plant manager of the entire mill.

Engineering progress and other factors brought to a focus in 1922 the question of still another change in the power equipment; and a careful study of the situation revealed that the wisest step would be to substitute oil for producer gas as a motor fuel. It was therefore decided to remodel the gas engines so that they could be operated as oil engines by the Price direct-injection system.

The reasons for changing the engines were: the cost of lignite, which had advanced from $1.50 to $3.25 a ton; the increased price of labor required to run the producers; the badly worn condition of the producers; and the fact that the engines, themselves, because of hard and continuous service, were in need of extensive overhauling. A further contributing factor was that the company had arranged for the use of fuel oil throughout the mill. There is ample warrant for the belief that the remodeled engines are $100 a day more economical than they were when working on producer gas.

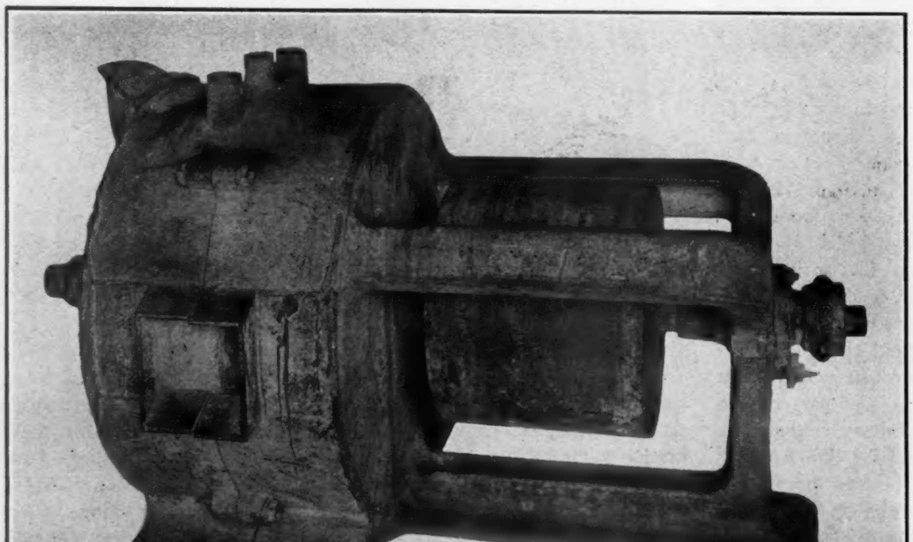
The oil employed is from the Laredo field in Texas, and is known as "Mirando" crude. It contains 19,200 B.T.U.'s per pound; has a specific gravity of 22 Beaumé; and weighs approximately 7.68 pounds per gallon. Taking the total number of kilowatt-hours generated in 1922, and the total amount of fuel oil purchased at $1.60 per 42-gallon barrel, the fuel consumption was .54 pound per kilowatt-hour.

A general view of the power plant of the San Antonio Portland Cement Company showing the direct-connected, 1,000-B.H.P. Price-Rathbun oil engine at the left and the two 480-B.H.P. units of the same make at the right.

Close-up of one of the two 480-H.P. Price-Rathbun oil engines at the plant of the San Antonio Portland Cement Company.

The overall efficiency of the generators, including excitation losses and windage, should be figured at 92 per cent. This would mean .3714 pound of this particular fuel per brake horsepower. It is authoritatively stated that approximately 18 kilowatt-hours of current are required per barrel of cement when manufactured in a modern mill where all the equipment is electrically driven. The cost of providing current with the gas-producer plant was on the basis of .7 cent per kilowatt-hour as compared with .4 cent per kilowatt-hour with the oil-engine plant. A consumption of three pounds of lignite per brake horse-power-hour, including stand-by losses, was formerly needful. The lubricating oil used during the year 1922 amounted to the equivalent of one gallon per 4,000 rated horse-power-hours.

In conclusion, it might be said that the present capacity of the San Antonio Portland Cement Company is 1,500 barrels per diem; and that improvements are in hand that will shortly make it possible for the mill to turn out 2,400 barrels daily. Looking back to our start in 1880, it is plain that we have traveled far along the industrial highway; and it is our intention to keep pushing forward by utilizing every mechanical development, every engineering advance that will make for economy of operation and increased output.



The original mill used for grinding cement at the plant of the Alamo Cement Company.

AIR-DRIVEN LOCOMOTIVES IN GERMAN MINES

COMPRESSED air locomotives are quite numerous in German mines. In the Dortmund district alone there were 624 in 1920, and they hauled about 15,000,000 tons of coal during that year. The compressed air in the storage mains is maintained at a pressure of about 3,000 pounds per square inch. The storage charge for the locomotive, which starts at approximately this pressure, is carried in long weldless steel cylinders, three or four in number and twelve to eighteen inches in diameter. They are practically as long as the locomotive and leave a seat for the driver in the rear. The necks of the bottles or receivers are held in place by a vertical plate, while the other or forward ends are held by a stout strap attached to the frame below. In operation, the air flows from the storage through a pressure reducer to a receiver, where a constant pressure of about 200 pounds is maintained.

The air, after leaving the first or high-pressure cylinder where it is used expansively, passes through a series of tubes in which its temperature is raised or restored to that of the mine air, and then it does its final work in the low-pressure cylinder. The distribution of the air is controlled within wide limits by balanced-piston valves and a link motion just as in a steam locomotive. With one charge of air the engine can travel with its load about six miles. The locomotives serve either as main-road or gathering locomotives, and weigh from 3½ to 7 tons. Their power is from 10 to 30 H. P. Still larger locomotives are used for tunnel work and in plants exposed to the danger of fire.

DIAMONDS FROM ARKANSAS

NEARLY 6,000 diamonds have been found in Arkansas, and some stones have been picked up in other states. The diamond fields of Arkansas are in Scott County, where a valuable diamond was first found in 1906 by John Huddleston, a farmer. The mule he was riding happened to kick up a stone of unusual brilliancy, which caught his eye. He dismounted, picked up the stone and put it in his pocket. A few days later the performance was repeated. The stones were sent to Tiffany & Company, New York, whose expert said "diamonds;" and soon afterwards Mr. Huddleston is reported to have sold his 40-acre farm for $36,000.

Though the diamond field of Arkansas has never achieved greatness, it has yielded a considerable number of fine stones/ the largest weighing 21.25 carats. Another stone weighed 17.86 carats. Many of the Arkansas stones are as fine as any found elsewhere and, according to Dr. George F. Kunz of Tiffany's, they include a large proportion of white stones, most of them of a high grade in color and in brilliancy and free from flaws. In describing several of the yellow, brown, and white stones from Arkansas, Doctor Kunz further states that "these are absolutely perfect and are equal to the finest stones found at the Jagersfontein mine or in India." A few of the Arkansas diamonds, it is said, have sold for as high as $600 a carat. Most of them, however, are uncut and have been placed in private and museum collections.

MELTING PLATINUM IN A GLASS TUBE

IT SEEMS incredible that several ounces of platinum can be melted in a small test tube of pyrex glass when it is considered that the melting point of that precious metal is above 3,000° F., whereas pyrex glass begins to soften when the applied heat takes on a red color. Platinum, at the melting point, is so dazzlingly white that it is blinding to the naked eye. This paradoxical condition, however, has been actually introduced recently by the Division of Metallurgy of the Bureau of Standards, in its experimental efforts to purify platinum.

This anomaly is at once cleared up when it is explained that the glass tube, which is one inch in diameter, is coated with a lining of thorium oxide—this protection being placed between the platinum and the wall of the glass container before the high heat is applied to the specimen of platinum. Thorium oxide is the most refractory oxide known, resisting a temperature of approximately 6,000° F. before it melts.

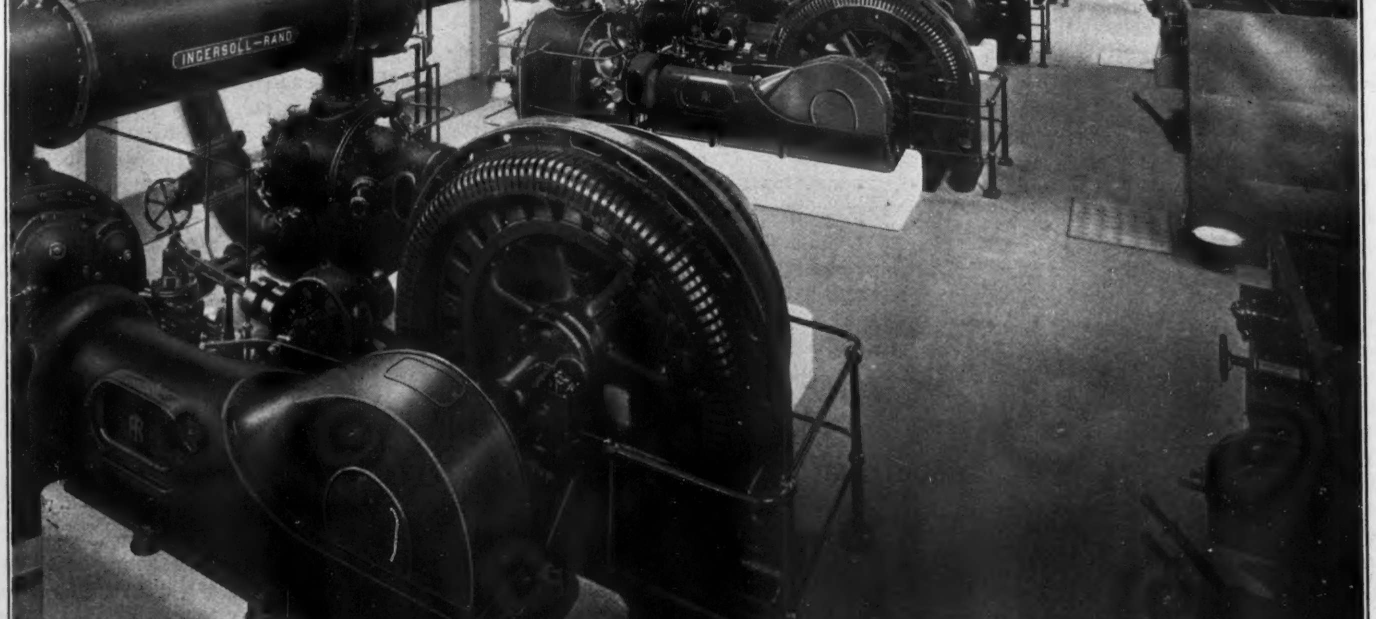
The melting of platinum, under this condition, is accomplished in the absence of air. According to delicate qualitative and quantitative tests made by the Division of Metallurgy, greater purity is thus insured for this valuable metal than by the hitherto prevailing methods of treatment. The absolute purity of platinum is desirable when it is to be used for thermocouples and resistance thermometers.

THE LITTLE PESTS

YEARS ago the Colorado beetle became suddenly notorious—threatening, as it did, the destruction of the entire potato crop; but in a comparatively short time it was completely circumvented and it figures no more in the newspapers. Now the boll weevil is more than threatening our cotton crop and challenges our ingenuity and resolution to check its ravages; and we are sufficiently optimistic to believe that its career also must soon be cut short.

These active destroyers, with locusts, caterpillars, and others, are chiefly formidable by reason of their numbers and the suddenness of their attacks; but now we have what we may call the California beetle, which is individually effective and most peculiar in its ways. Its specialty is the boring of lead—it cannot eat or penetrate pure gum rubber—but whether or not it eats the lead we cannot say. It attacks telephone cables, boring a hole about 1/10 inch in diameter entirely through the sheathing. Moisture enters the cables through these holes, causing a short-circuiting of the wires and effectively interrupting service. One hole may put from 50 to 600 or more telephones out of use for from 1 to 10 days.

Department Bulletin 1107, *The Lead-cable Borer in California*, tells about the trouble and the expedients adopted. Poison seems to have little effect, it being assumed that the borer is too busy with the lead to bother with the poison. Beef tallow will stick to the beetle and suffocate it, poor thing, and has been used with some success.



Compressor equipment of one of the leading collieries in the Durham district of England. This plant is made up of four PRE-2 direct-connected, electrically-driven units, each of which is capable of delivering 2,500 cubic feet of free air per minute at a pressure of 75 pounds to the square inch. Each unit is driven by a General Electric 3-phase, self-starting, synchronous motor wound for a pressure of 2,750 volts and a periodicity of 40 cycles. The motor makes 200 R. P. M. The discharged air from each compressor is carried through 10-inch piping, with easy bends, to its associate aftercooler. From the aftercoolers, the air is then conveyed to two air receivers 20 feet long and 6 feet in diameter—one receiver taking care of the air from two compressors. Receivers are coupled together or, if desired, can be used independently. The air from the receivers is conveyed down the pit by a 12-inch main, and this air is used for operating coal cutters. for haulage, etc. The circulating water for cooling purposes is supplied by a Cameron centrifugal pump having a capacity of 550 gallons a minute.

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—Founded 1896—

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EDITORIALS

ELIMINATE WASTE IN INDUSTRY

THIS, in substance, is the text of numerous preachments by production engineers and the conclusion arrived at by the Department of Commerce as a result of researches which that Government organization is conducting in the field of simplified practice. *The Sun*, of Baltimore, has dwelt upon this topic editorially during the past month, and the following paragraphs are abstracted in their entirety from that able source because of their clarity and their economic pertinence.

"The researches cover all of the field involved in utilizing left-over materials, in making by-products, and also in eliminating surplus styles and types of products. There are scores of industries which, tradition-bound, drift along with a great diversity of what motorists know as 'spare parts,' no attempt being made to simplify or standardize them. These different types and sizes mean a large investment in stock for the retailer, a slow turnover, and uncertain profits. Standardization is the leading formula for the elimination of industrial waste.

"Experts say that American business is on the eve of an efficiency gain which may save at least $10,000,000,000 a year to the nation. These gains include such calculations as are involved in the reduction of capital tied up in stock and raw materials, and in less space devoted to storage; fewer changes in machine set-up, and as a result a more continuous use of machinery; through simplified inspection and a gain in labor efficiency, etc. None of these things is new; they have been talked of by industrial engineers for years; but only recently have they developed from the theoretical to the practical phase."

What is apparently necessary is for all walks of our industrial life to practice this doctrine of efficiency daily. The magnitude of the potential reward should, in itself, be sufficient to spur us on to betterment.

ANOTHER TRANSATLANTIC CABLE LAID

THE WORLD marveled 57 years ago when the Great Eastern completed her memorable work of binding America with Europe by the first successful Atlantic telegraphic cable; but comparatively few of the many millions of people concerned have given more than momentary heed to the recent landing on the south shore of Long Island of the Commercial Cable Company's new transatlantic line of communication.

A moment's pause will make the importance of that accomplishment apparent. Despite the advent of wireless and the establishment of powerful radio stations which are capable of spanning vast terrestrial distances, the fact remains that this newer method of electrical intercourse has not superseded the older order of long-range telegraphy. Traffic over the submarine cables linking North America with Europe has increased fourfold in the last decade, and yet, until the other day, nothing had been done within that period to augment these subaqueous nerves of communication.

The cable just laid is of greater capacity than its predecessors, and represents the present acme not only of the art of cable construction but of the technique of transmitting rapidly to and fro under water electrical impulses for thousands of miles. The cost of the cable, without counting the expense of its laying, has been put at $15,000,000; and to get it properly in place on the sea bed has required the service of specially constructed craft manned largely by a personnel trained for that hazardous and extremely exacting work.

The man in the street little knows what painstaking is required in fabricating a submarine cable properly insulated and duly armored with a wrapping of steel wires strong enough to withstand the rub of a rocky bottom and the continual sweep of tidal currents. Not only that, but this conduit, by which feeble electrical impulses carry the daily heart beats of national life from shore to shore, must be proof against the penetrating persistence of deep-sea worms and sufficiently sturdy to hold its own against attacking swordfish or other larger denizens of the ocean. And should a cable break in the laying, or be severed, or leak from any cause when once in place, the task of picking up the parted sections or of raising the defective cable at the right point may require grappling for it miles below the surface and sweeping wide areas of the sea. In short, the story of cable laying and cable maintenance is an epic filled with thrills well calculated to hold the reader spellbound.

OUR WIDENING NETWORK OF GOOD ROADS

BY A PARADOX growing out of modern progress our public highways are rapidly becoming just as vital to our economic life as were the roads built by the conquering Romans to facilitate communication.

For decades we gave as a people comparatively little attention to the country's interlinking rural highways owing to the fact that we looked to our railroads to transport the vast burden of our freight and our express and postal matter. The coming of the automotive vehicle, as we all know, blazed the way for a new order of traffic, and the development of the self-propelled truck has forced us to recognize the need of suitable roads everywhere.

At a recent convention of the Virginia Good Roads Association, the president of that organization declared that the automobiles and trucks in that state represent an outlay of $150,000,000 and that the annual wear and tear on them, induced by bad roads, was equal to a sum sufficient to cover half the cost of building the state's system of highways. Here is a new aspect of the problem which has commonly been viewed from the opposite angle—that is, the depreciation of the roads induced by automotive traffic.

Engineering research and experience have revealed that an imperfectly surfaced road is not only hard on the automobile and the motor truck but self-injurious through the damaging reactions which are set up between the road and the heavily laden and rapidly moving wheels of the power-driven vehicles. Further, we know now how roads should be constructed so that they will stand up under service and do the least harm to the cars and trucks running over them. Mechanical facilities are available today not only for the proper building of road beds and their surfaces but for the detection of any subsurface defects a good while before the latter manifest themselves superficially.

The road-building season of the present year will add hundreds of miles to the nation's system of improved highways. The Bureau of Good Roads of the United States Department of Agriculture has lately compiled data which disclose an expenditure of $15,000,000 more in 1923 than in 1922 on work of this sort—the figures being based upon returns from 21 scattered states. In this movement, the South has made great headway in the last twelvemonth. It is authoritatively stated that more than 10,000 miles of highways were completed or taken in hand in 16 of the southern states during 1923, involving an estimated outlay of $165,000,000.

Until two or three years ago, unbound macadam was the only kind of hard road laid in that section of the country; but today anywhere from 20 to 50 per cent. of all state highways being built in the South are hard surfaced and finished with asphalt or some other suitable material. It is prophesied that in the near future it will be practicable for the northern or the eastern tourist to motor to Florida over perfect roads every mile of the way. Similarly the agricultural abundance of the Southland can be sped northward more readily at seasons when it will bring profitable prices in the markets of the less-favored states.

LIGNITE TO YIELD A SMOKELESS FUEL

WITHIN the bounds of three of our western states are located easily mined deposits of lignite amounting to 964,000,000,000 tons, and within the country as a whole there are 1,051,290,000,000 tons of this same form of low-grade coal. But what is more interesting is the fact that this relatively indifferent fuel can be converted into one possessing many of the admirable characteristics of anthracite coal.

The United States Bureau of Mines has been working for several years upon the problem of devising apparatus which would make it commercially practicable to carbonize lignite at a comparatively low temperature so as to produce a cokelike residue which could be briquetted and utilized as a substitute for anthracite. Indeed, the aim has been to render the lignite usable in considerable areas of the country where well-nigh all the coal consumed has to be transported from afar. Happily, the experts of the Bureau have been successful in their work.

An oven has been perfected within which it is feasible to turn lignite into a smokeless fuel having substantially the same thermal efficiency as that of the better grades of anthracite. In its experiments, the Bureau has had the coöperation of officials of the Canadian Government, for the Dominion also possesses enormous deposits of lignite and has long desired to find some way to put that fuel to effective service. The Canadian authorities built a similar unit and subjected it to thorough testing. The outcome was entirely satisfactory; and the technicists of both Canada and the United States are convinced that there has now been developed an oven which may be deemed entirely practicable for commercial application.

The importance of this engineering accomplishment can be readily appreciated by the coal-burning public.

THE UNITED STATES IS AN INDUSTRIAL COUNTRY

IT IS USUAL to speak of America as a farming country. A generation ago the size of the crops was the best gage of business conditions, because the crop production then exceeded in value that of any other industry. America used to be the granary of the world.

Few of us realize that the value of the commodities manufactured in the United States is now nearly double that of its farm products. It is true, of course, that much that comes from the farm goes into manufactured goods and is listed as such. Wheat, for instance, is so recorded under the head of flour, and animal products are used in the packing industry and serve to build up the figures of manufactured articles.

The Department of Commerce has recently published a statement showing that in the year 1921 the value of manufactured products in the United States was over $43,500,000,000. This was a falling off of 30 per cent. as compared with 1919, when the value was over $62,000,000,000. This difference was largely due to the business conditions in 1921 as against those prevailing in 1919—the latter being the peak year following the war. Some of it might also be attributed to decreased prices.

ONCE MORE THE EARTHQUAKE TAKES ITS TOLL

THE WHOLE WORLD has recently been appalled by the sudden aggregation of natural forces that have laid low a wide section of populous Japan and caused the death of hundreds of thousands of human beings and the destruction of property valued at billions of dollars. As might be expected, the peoples of the civilized nations have and are responding generously with every possible form of practical relief, emphasizing again the universality of the brotherhood of man.

In time, and probably within a short span, the outward traces of the tragedy will be obliterated—thanks to the industry and the indomitable courage of the Japanese. They have weathered many a storm in the past, many a staggering disaster; and as a race they have been reared if not actually born "in the cradle of the volcano and the earthquake." The price Japan has recently been called upon to pay inexorable Nature is the price which must inevitably be paid for the pretentious developments of modern progress. That is to say, Tokio and Yokohama—especially the latter—had attained much of the dignity and acquired many of the facilities which characterize up-to-date occidental cities. These urban features were promptly shattered, disarranged, or otherwise damaged just when their stability or effective service would have meant most in saving life and in safeguarding property.

It is an interesting matter of latter-day history that Japanese engineers, a few years ago, made a series of exhaustive model experiments in an effort to neutralize the destructive forces of the not-unfrequent earthquake by devising types of structures that would best withstand seismic tremors and be at the same time more in keeping with architectural practices abroad. Despite their patient research and their skill, it would seem that the Japanese have not yet evolved buildings that are more secure in the long run, when local conditions are considered, than the somewhat flimsy and lowly structures which have for generations characterized the habitations and the business houses of the Land of the Rising Sun.

True, the newer types of buildings have held their own against earthquakes of moderate severity, and they have been successful in this by reason of the ingenuity displayed in their special designing; but it is self-evident that man cannot pit his cunning against Nature's incalculable forces which are aroused by any tremendous and far-reaching movement of the earth's crust.

FALL OF COMMODITY PRICES

SINCE APRIL of the present year there has been a marked decline in commodity prices. Wheat, for instance, has dropped 18 per cent. from the highest point in 1923; pig iron, 19 per cent.; copper, 17 per cent.; lead, 25 per cent.; tin, 25 per cent.; coal, 46 per cent.; petroleum, 18 per cent.; cotton, 28 per cent.; and silk, 25 per cent.

It is not difficult to understand the cause of this when we realize that prior to April, commodity prices had been rising by leaps and bounds. In 1921 and in a part of 1922 there had been such a slump that it was natural to expect a rebound.

Wages have not followed the trend of commodity prices. The Bureau of Labor's index of over 400 commodities is at present 153—100 being par in the year 1913, or, in other words, 53 per cent. above par. In the New York District, the index for unskilled labor, as well as the average weekly earnings of factory workers in New York State, is 218, or 118 above par.

SUPERIORITY OF AIR BRAKES

THE *Electric Railway Journal*, in a recent issue, comments editorially upon the results of a series of air-brake tests made by the Central Electric Railway Association. The committee, in its report, concludes that for a car equipped with air brakes the best practice is to apply emergency air and sand and, at the same time, to throw the electric controller to the off position.

The greatest braking force that can be used on a car is that which will just fail to lock the wheels. With excellent track conditions this results in a retardation at the rate of from 4.5 to 5 miles per hour per second. It is significant that in the tests the average rate of retardation was generally greater with emergency application of air than with the electrical methods.

One of the prime difficulties with the electrical method of braking is that if sufficient force is used to make a rapid stop then there is danger of a closely-set circuit breaker blowing out, which, of course, removes all the braking force and allows the car to run without restriction. Both this and dynamic braking, in which the motors are used as generators, place severe strains upon the electric equipment that sometimes lead to burned out windings or connections which, in turn, tend to kill the braking effort.

The real value of the electrical method of braking lies in the fact that if anything happens to the air brakes to make them inoperative, an auxiliary electrical brake is called into service. For this reason, it is not well to belittle the electrical form of braking, though air should be relied upon as long as it is available.

HELICOPTER FLIGHT

THE helicopter seems to be developing quite slowly; but, at the present stage, every showing it makes is of interest. Oemichen recently remained above the ground for five minutes in a machine of his own invention, and since then he has made a flight in which he completed a circle of over 130 yards, 6 feet above the ground, returning to his starting point. His machine is fitted with four sustaining or lifting propellers, a direction propeller, a gyroscope to secure equilibrium, and a 120-H. P. motor. About the same time, another inventor, Pescara, completed a circuit of about 65 yards with a helicopter of different design.

West China, which has a population of 100,000,000, is without one mile of railway. Accordingly, the people are not only cut off from economic communication with the rest of their country but from the world as well.

W'OT CAN I DO FOR EE?

By D. E. A. CHARLTON

W'EN a chap is doin minin, h'it ain't
h'often that 'ee's pinnin
For to see a 'eap o visitors come walkin
daown tha drif.
Like h'as not they want to h'ask 'ee h'all abaout
tha sort o task 'ee
Be a-doin from tha start o things h'until tha
close o shift.

S'posin thee don't min their talkin, thee is glad
w'en they start walkin,
For h'it means that thee can start tha drill
an 'it tha rock once more,
For tha minin cap'n's judgin from tha drillin
an tha sludgin
An tha footage from tha breakin w'ot thee
does in minin h'ore.

Naow an then w'en thee's been drillin, 'ittin
h'up a pace that's killin
An thee feels h'as though tha bloody shif 'as
simply gone for naught—
For h'it seems tha drills be stickin an tha valves
be h'all a-clickin,
And thee naws that w'ot thee 'as done bean't
near to w'ot h'it ought—

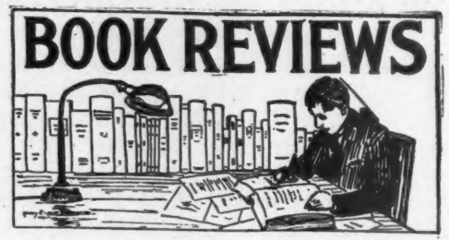
Thee is h'apt to start a-thinkin h'as thee's
standin there a-blinkin,
That per'aps tha blame may be h'on thee h'as
well h'as on tha drill,
So thee starts firs h'off to figger 'ow tha job
will pay thee bigger,
So that, like h'as not, thee may fin h'out h'it's
'ard to fill tha bill.

But for h'all this kine o trouble there's a way
h'out—thee can double
H'on tha h'output if thee makes tha mos o
h'all that's h'offered thee.
H'all thee needs is jus to 'arken to tha chap 'oo
comes a-markin
Daown tha things ee fin's—tha chap oo sez,
"W'ot can I do for ee?"

W'en a chap is doin minin, h'it ain't h'often
that 'ee's pinnin
For to see a 'eap o visitors come walkin
through tha mine,
But h'it's worth your w'ile to taper h'off—just
put this daown h'on paper—
W'en tha service h'engineer is raoun, 'ee'll
never waste your time.

Canned North-Pacific whale steak is making a hit wherever introduced. We are told that the demand for this foodstuff is so great that the pack now being prepared was disposed of long ago. Practically all the British Columbia whale meat is being shipped to England for redistribution abroad.

In our September issue, where we cited a number of things that could be done in or by a kilowatt-hour, we stated, unfortunately, that "one-third should be added to each item in computing the work of a horse-power-hour." The sentence should have read: "One-quarter should be subtracted from each in computing the work of a horse-power-hour."



ENGLISH MANUAL FOR BUSINESS, by Robert Winternitz. A book of 96 pages, published by A. W. Shaw Company, Chicago and New York. Price, $1.00.

THE PURPOSE of this volume is to help the business executive who is anxious to improve the quality of his written English—incidentally the English used by him and all too faithfully transcribed by his stenographer or so-called "secretary." As many a man in a responsible administrative position has discovered to his mortification, letters are offered him for signature, and others are signed for him, that are faulty in more ways than one. Not only that, but often the shortcomings do not become apparent until too late. It pays to be particular in expressing oneself, and the present volume is admirably calculated to help to this end.

THE MERCHANT MARINE, by Rear-Admiral William S. Benson, U. S. Navy. A work of 183 pages, published by The Macmillan Company, New York. Price, $1.75.

IN THESE days, when the nation at large is not yet fully alive to what a fleet of trade can and should mean to the industrial life of the entire country, a book such as Admiral Benson has written meets a real and vital need. Whatever may have been the conditions in the past which permitted us profitably to concentrate upon domestic commerce rather than to seek markets abroad, we cannot do this now and find paying outlets for the surplus of our manifold fields of production. It is reasonably established that both our prosperity and national security depend to a considerable measure upon the moving of the lion's share of our exports and imports in ships flying our own flag. Those that may be disposed to doubt this conclusion, let them read without bias what Admiral Benson has written.

ULTRAVIOLET RADIATION, by M. Luckiesh, Director of Applied Science, Nela Research Laboratories. This is a volume of 258 pages, well illustrated. Published by D. Van Nostrand Company, New York. Price $3.50.

THE PRESENT book is the ninth of a series written by the author and dealing with various aspects of light and color. Because of his long experience in this particular field of physics and research, he brings to his subject an authoritative force which makes his treatment especially valuable. In his preface, Mr. Luckiesh points out that 120 years have elapsed since the discovery of ultraviolet radiation, and that latterly a great deal of attention has been given to its properties, production, and applications. Unfortunately, much of the literature on the subject is confusing; and the primary aid of the book is to offer authentic data of such scope as to be useful to those who are interested in this particular field. There is every reason to believe that the writer has been eminently successful in filling a growing and a long-felt want.

Explosions in Air Compressors is the title of a paper which was read by J. A. Vaughan during the March meeting of the South African Institution of Engineers, at Johannesburg. Mr. Vaughan mentions that "during the last sixteen years, in the Union of South Africa, there have been sixteen official inquiries by the Department of Mines and Industries into the circumstances attending explosion or firing in the compressed air systems of mines in the Transvaal. Ten of these were cases of explosion, while in the other six cases there was only burning in the pipes or passages through which the gas passed." Anyone interested in this subject should read Mr. Vaughan's informative paper.

Dust Problems and Their Solutions is the title of an interesting and instructive booklet recently issued by the Midwest Air Filters, Inc., New York City. The purpose of the brochure is to point out the various solid impurities present in atmospheric air and to describe the filters manufactured by the company to deal with these impurities. Clean air is essential not only to health but to the successful operation of a diversity of industries.

In order to assist the American business man in the handling of his foreign advertising campaigns, the Foreign Tariffs Division of the Bureau of Foreign and Domestic Commerce has in course of preparation a series of bulletins showing in detail the restrictions in each of the sections of the world. The first of this series is Trade Information Bulletin No. 122, entitled *Shipment of Samples and Advertising Matter to the British Empire*, copies of which may be secured by addressing the aforesaid division at Washington.

The Bureau of Mines, Washington, D. C., has announced the publication of the following List No. 93:

TECHNICAL PAPER 294. Progress of investigations on liquid-oxygen explosives, by S. P. Howell, J. W. Paul, and J. L. Sherrick. 1923. 91 pp., 6 pls., 18 figs.

TECHNICAL PAPER 321. Anhydrous aluminum chloride, by Oliver C. Ralston. 1923. 38 pp., 12 figs.

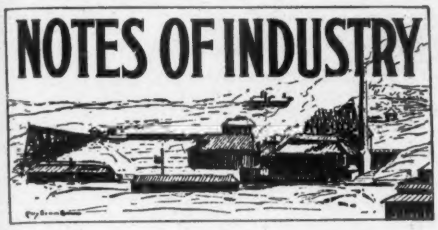
TECHNICAL PAPER 326. Fires in steamship bunker and cargo coal, by H. H. Stoek. 1923. 52 pp., 4 figs.

TECHNICAL PAPER 327. Accidents at metallurgical works in the United States during the calendar year 1921, by W. W. Adams. 1923. 31 pp.

TECHNICAL PAPER 331. Metal-mine accidents in the United States during the calendar year 1921, by W. W. Adams. 1923. 96 pp.

TECHNICAL PAPER 333. Permissible explosives, mining equipment and apparatus approved prior to January 1, 1923, by S. P. Howell, L. C. Ilsley, D. J. Parker, and A. C. Fieldner. 1923. 22 pp., 1 fig.

The Johore causeway, connecting Singapore with the mainland, was opened October 1.



It is not generally known that the crude oil obtained from different pools, and often from different formations in the same pool, is usually dissimilar in composition and in properties—yielding distillates that vary in these respects as well as different quantities of each distillate. Nevertheless, by scientific handling, the numerous grades of crude oil are made to give a uniform product.

The United States practically controls the ice-making machinery business of Japan.

Copper to the amount of 105,000,000 pounds, or 10.7 per cent. of the total production, was used last year in the automobile industry.

In the first three months of 1923, oil tankers, most of them carrying California crude, paid $1,279,000 in Panama Canal tolls. In April, following, approximately two-thirds of the intercoastal tonnage passing through the canal consisted of tank ships. It is interesting to note in this connection that a year earlier—April, 1922—but one American tanker used the Panama Canal for intercoastal trade. Today, California oil is thus being made available to markets in the East, 3,000 miles away, at the rate of 150,000 barrels a day—a flow equivalent to that of eight overland trunk pipe lines working to capacity.

Mexico has 139 cotton mills employing 40,000 people and producing 350,000,000 yards of cloth per annum.

It is reported that M. Risler, a Paris engineer, has solved the problem of producing light without heat as the glow-worm is said to do, but in a different way. He takes a glass tube, lined with a phosphorescent material, and in it he produces an attenuated vacuum of 0.0008 inches of mercury. On passing an electric current through the tube, the phosphorescent material glows with extreme brightness at an extremely small consumption of energy.

During the twelvemonth ending June, 1923, the exports of crude petroleum from the United States showed an increase of 46 per cent. over those of the preceding year.

It is said that the cost of sugar cane in Hawaii, delivered at the factory, is somewhere around 90 per cent. of the total cost of manufacturing the raw sugar. A high recovery of sucrose from the cane is, therefore, important; and any machinery that assures an increased yield generally justifies its installation. This is made plain by the fact that an additional recovery of 1 per cent. on a 16,000-ton crop, with sugar selling at $80 a ton, would mean a revenue of $12,800 a season.

Automobiles in the United States now consume nearly 6,000,000,000 gallons of gasoline a year. This amount of "gas" would fill a lake a mile deep and covering 3½ acres; and the job that confronts the oil producers is to see that this lake, which grows larger steadily, is regularly replenished.

Contrary to "calamity howlers," our trade with South America shows that European competition has not strangled American effort. For the fiscal year ending June 30, 1923, compared with the similar period of 1921-1922, our total exports to that region increased 35 per cent., while the imports jumped 63 per cent. As a matter of fact, the increased trade with our southern neighbor was greater than the improvement in our trade with any other foreign market except that of Oceania.

A concession for the installation of plants for the extraction of gasoline from natural gas has been granted in Mexico. This is in accordance with the policy laid down in the decree of November 22, 1922, requiring oil companies to make use of the natural gas which heretofore has been allowed to escape wastefully. According to the terms of the concession, it is agreed that a sufficient number of plants will be equipped within a period of five years to produce at least 882,850 cubic feet of gasoline annually.

In the building trade in Johannesburg, South Africa, a steadily increasing use is being found for a combination material made up of asbestos and cement. The base is fibrous asbestos rock which is impregnated with slow-setting Portland cement; and the board is built up in layers—the fibers crossing each other and forming a homogeneous mass of great strength and toughness. Apart from being fireproof, it is claimed that the material helps greatly to decrease construction costs. A firm in Johannesburg has patented a process for reinforcing this asbestos-cement building board with steel.

Owing to the success attending the utilization of water power in the Department of the Manche, France, a second and much larger hydro-electric plant is being planned to take care of the increased demand for power in that district. The plans involve the construction of a dam for a lake reservoir and a power station.

It is said that 2,500,000 ice-cream cones are made in Chicago every day. The baking of them is a delicate operation; and gas is used for the purpose. The consumption of gas alone is estimated at 72,000,000 cubic feet a year.

CHANNEL TUNNEL PLANS

PLANS for the inevitable Channel Tunnel, to connect England and France at their nearest points, are now complete in almost every detail as to mode of construction, cost, etc. A recent interesting memorandum of the Channel Tunnel Engineer, Sir Percy Tempest, tells this story.

Beneath the sea at a convenient depth is located a stratum which is the ideal material for tunnel construction. It is a chalk infiltrated with clay, impervious to water, and of such a thickness vertically as to allow the placing of the tunnel higher or lower as conditions may dictate. A boring machine has been constructed and thoroughly tried which will drive a heading 12 feet in diameter at a rate of 120 feet a day. Machines of this type, started from each end, would meet in 2½ years.

The main tunnel would be built parallel to this pilot heading, which would furnish many points of attack at once and serve as a passageway to convey all the material to be removed, so that 18 months additional or, say, 4½ years in all is estimated as sufficient for the completion of the work.

THE GASOLINE SHOVEL MAKES GOOD

A NEW ¾-yard gasoline, rope-thrust, revolving shovel, known as the 20-B, has just been announced by the Bucyrus Company, South Milwaukee, Wisconsin. This shovel contains the same unique features which are embodied in the 30-B gasoline machine put out by the same manufacturer a year or so ago.

Like the 30-B, the ingenious rope-thrust arrangement not only does away with the necessity of engines, gears, clutches, chains, or complicated shafting on the boom but at the same time gives this shovel a powerful drive behind the thrust, inasmuch as the whole power of the main engine is behind it.

The new gasoline revolving shovel.

This device has proved itself on the 30-B shovel under the toughest digging conditions in all parts of the world, and its manufacturers believe that it has literally created, in itself, a new era for the small shovel driven by an internal combustion engine.

AN EARLY PNEUMATIC DISPATCH TUBE

THE PRESENT weekly issues of *The Engineer*, London, each contain a paragraph giving interesting items from its publication of corresponding date 60 years ago. In a recent number we read an account of the working of an experimental pneumatic dispatch tube, 600 yards long, that was laid between Euston Station and the District Post Office. During six months' service, 30 trains per day were dispatched—the time of transmission occupying 70 seconds with a daily cost of about $6.00. The scheme to lay a main tube, 54 inches in diameter, from Euston Station to the General Post Office and thence to Gresham Street was also mentioned.

NEW FLYING MACHINE

WE LEARN through *The Engineer* of the advent of a flying machine of novel design, the invention of a young Spanish engineer. The description of the machine is by no means clear, for which, of course, *The Engineer* is not responsible. It is neither an aeroplane, nor a helicopter, nor an orthopter, but something between all three.

There is an aeroplane body with elevators, a tail fin, a rudder and ailerons without wings, and an ordinary 2-bladed tractor screw. From about the center of gravity of the machine a shaft extends upward for a few feet, carrying a large 4-bladed propeller, the blades of which project in a plane making a small angle of incidence to the horizontal. No power is supplied to rotate this large screw; but when the machine is propelled forward by the tractor screw the large propeller turns like a windmill and develops lift. It appears that the blades of the large screw are hinged to the shaft, so that each blade may independently assume a stable position under the joint action of the lift and centrifugal force. The shaft, as a whole, is apparently pivoted, so that it may automatically take up the position prescribed for it by the resultant forces and moments acting upon it.

The object of these arrangements is, apparently, to neutralize the tendency of the machine to bank under the inequality of the lifts developed by the separate blades of the large screw. During tests at Madrid, the machine is said to have shown its ability to descend almost vertically with the engine cut off, the horizontal landing speed not exceeding six miles an hour.

TO MEASURE THE POWER OF A HORSE

IT IS now about a century and a half since James Watt put the power of a working horse at 33,000 minute-pounds, and that figure has been accepted and adopted the world over as standard. It has been almost universally conceded that the figure is too high, but that has not at all affected the practical use of it. Now it is proposed—"better late than never"—to determine in a scientific way what is the actual power of a horse and what would be a reasonable horse-power.

This is to be done shortly at the Iowa State Fair by the engineering department of the Iowa State College. A specially constructed wagon has been designed; and by means of a hydraulic pump, driven from the wheels, it will be possible to put on any predetermined load and to maintain a uniform load resistance. Various loads up to the maximum will be tried, as well as various load conditions and longer and shorter periods of working, and from all the data we may expect a "desperate" average to be deduced which we will be at liberty to accept or not.

Mining and quarrying machinery finds a not inconspicuous place in the list given out by the Chamber of Commerce of the 100 chief exports of the United States for the year 1922. The total value was $6,571,000, and this figure did not include boilers and engines for power plants, locomotives, and other equipment.

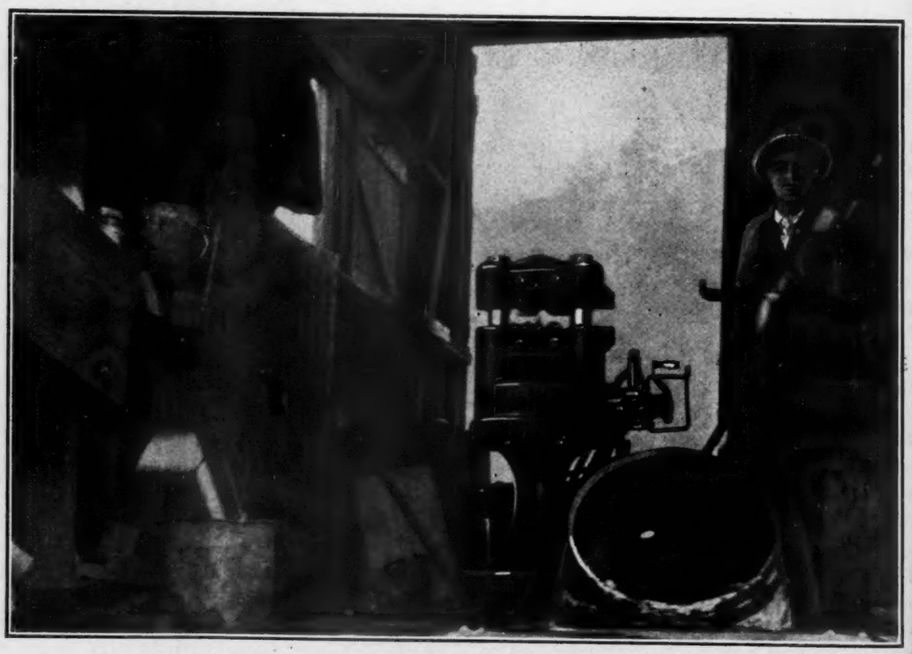
MOBILE WORKSHOP SPEEDS DRILL SHARPENING

THE superintendent of the Virginian Limestone Corporation, Mr. W. B. Bobbitt, recently showed his ingenuity in providing a convenient traveling machine shop for sharpening drills. This mobile plant is in use at the quarry at Klotz, near Ripplemead. Mr. Bobbitt noticed that a great deal of time and energy was being consumed in taking the steels from the drills to the machine shops and back again to the job—the distance to be covered was often so great that a considerable loss of time resulted. There were repeated delays that seriously interfered with the work; and drills were not always at hand when they were needed.

The old steam shovel which was dismantled and equipped as a mobile blacksmith shop.

Luckily, Mr. Bobbitt hit upon a plan to get rid of these vexations. An old Vulcan shovel was standing around and not doing enough to pay for its keep. He decided to put it to work in a new capacity, and, with this in mind, he stripped it of all its machinery; repaired the body; and proceeded to fit it up with modern equipment for sharpening drills on short notice.

As a result of his planning, the machine shop on wheels has been provided with an air-driven "Leyner" sharpener, a forge, an anvil, and such other tools and small appliances as are required for work of this kind. It was decided to leave the regular railroad trucks on the remodeled shovel so that it could be moved from place to place and kept within easy reach of the operations. An air line is run out from the compressor at the quarry. The whole scheme works very well: there are none of the old delays, and the regular shops are thus relieved of the handling of the drill steels.



"Leyner" sharpener mounted in the portable blacksmith shop.

Electricity is continually adding to its activities on the farm as elsewhere. An electrically heated hatchery, with a capacity of 100,000 eggs, is in successful operation in Oregon. The incubator controls also the brooder of corresponding capacity.

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